THE QUARTERLY

JOURNAL OF SCIENCE.

APRIL, 1870.

I. MEGALITHIC STRUCTURES OF THE CHANNEL ISLANDS: THEIR HISTORY AND ANALOGUES.

By Lieut. S. P. Oliver, Roy. Art., F.R.G.S.

The Cromlechs in Jersey and Guernsey and adjacent islands partake of the character of the French *Dolmens* and *Grottes aux Fées*, as well as the *Gangrifter* (gallery-tombs) of the Swedes, the *Jettestuer* (chambered tumuli) of the Danes, and the German *Hünenbetten*.

Our word "cromlech," however, is so often applied to such widely different structures, that there is no wonder if it sometimes misleads foreign archæologists. The cromlech of the English antiquarian is the same as the Welsh and English "*quoit*," such as *Arthur's quoit* or *coetan*, near Criccieth; *Lanyon quoit*, and *Chun qwoit* and others in Cornwall; *Stanton Drew* "*quoit*," in Somersetshire; the *Kitt's Koty* or *Coit*, near Maidstone; and the *Coit-y-enroc*, in Guernsey. Now, we can quite understand what we mean when we use the word cromlech to be identical with all these; but the French archæologist, when he uses the word cromlech, is right only when he applies it to a circle of upright stones, like the Hurlers and the Nine Maidens in Cornwall; thus the bardic circles convey a very different meaning to the Dolmen, or Table of Stone (*Dol* a table, *moen* a stone), when used by our Gallic neighbours.

Professor Sven Nilsson defines the English cromlech as synonymous to the French Dolmen, the Scandinavian *dös,* and the *dyss* of Denmark, consisting of one large block of stone, supported by from three to five stones arranged in a ring, and intended to contain one corpse only,* several of these *dorsar* being sometimes enclosed in circles of raised stones.

Following, however, the nomenclature given by the late Dr. Lukis, we cannot be far wrong in assigning the word cromlech to all elaborate megalithic structures of one or more chambers, in which category the passage-graves may be included. Nilsson has clearly pointed out how the gallery or half-cross tombs are close imitations, if not actual adaptations, of the original dwelling-houses of the ancient Pre-Celtic Scandinavians, a people not dissimilar in their mode of life to the present Arctic nations of Esquimaux; also how these galleried-huts were but make-shifts in the plains for subterranean caves and grottoes in the mountain region from whence their race originally sprang.

---

* Nilsson on 'The Stone Age,' pp. 159.

As regards the cromlechs in the Channel Islands, their chief characteristics may be briefly stated as follows:—

(1.) The large western chamber, composed of large, erect, and, at least on the inner side, flat slabs of granite,* from six to eight feet high, arranged in a circular or horse-shoe form, supporting an enormous capstone (the lower side of which is also flat), the largest stone in the whole structure. At the west extremity of this chamber is the largest of the erect slabs, a flat polygonal stone, as broad as it is high, the remaining uprights being generally less broad than they are high. This chamber is sometimes divided into smaller compartments or kists. A good example of these divisions is to be found in the cromlech at Mont Ubé, Jersey, from which, unhappily, the capstones have been removed many years since.

(2.) The covered gallery or passage leading to the great west chamber from the east. The stones forming this, both erect side blocks and granite imposts, being largest at the western end, and diminishing in height, size, and distance apart towards the eastern entrance. This avenue is sometimes so modified as to seem a mere prolongation of the west chamber, the capstones diminishing in regular order from the huge block at the west to the small one at the east, so that the whole structure is bottle-shaped. The gallery is frequently divided by stone partitions, and there are indications of thresholds where doors may have existed.†

(3.) The addition of kists outside the main structure, of a later period; notably conspicuous in the cromlech Dé-hus.

(4.) The structure surrounded with a stone circle, the centre of this circle generally in the western chamber; the circles are of the same dimensions throughout the islands, *viz.* 60 feet. From this circle or peristalith in some cases are traces of serpentine avenues or approaches, probably indicating similar forms to those of Abury. These avenues are seen best at L'Ancresse. At the Pocquelaye Cromlech there are remains of a double stone wall encircling the structure; between these are four small uprights, which seem as though they had formed a portion of a peristalith.‡ The peristalith of the Couperon Cromlech is *oval*.

---

* Except the Couperon Cromlech, Jersey, which is built of local conglomerate.

† Compare Sir John Lubbock's 'Description of the Danish Tumulus in the Island of Moen,' p. 105 'Pre-historic Times.'

‡ See view in 'Illustrated London News,' January 15th, 1870.

(5.) All the cromlechs were formerly covered with a tumulus of earth; these remain in many instances, at Creux des Fées and Du Thus, but a large proportion have been denuded of their earth-mound either by accident or design, as L'Ancresse, Le Trepied, Mont Ubé, Le Couperon, the Pocquelaye, &c.

These are the chief external characteristics of these stone structures; when we examine their interiors we find the following noteworthy points:—

(1.) Thick layers of limpet shells, forming a hard concrete, through which a pick-axe is forced with difficulty. The solitary exception to this general find is the cromlech of Ville Nouaux, in Jersey, where no limpet shells were found when explored in May, 1869, by the author.

(2.) A vast quantity of human bones, with bones of animals, showing that the structure was used as a catacomb, and that interments had been made for a long period. Pavements of flat sea-worn pebbles, over successive layers of interments, point to the same conclusion. No bones, however, were found at Ville Nouaux.

(3.) The presence of rude pottery and stone implements, and absence of bronze or iron.

(4.) The position of skeletons indicates that they were buried in a sitting posture, similar to those found in the Scandinavian tumuli.

(5.) Absence of any attempt at ornamentation of the stones similar to the engraved rocks of Gavr'Inis. Exception, the cup-markings on the Kistvaen, in centre of L'Ancresse Common.

One curious characteristic of these monuments may be noticed more in Guernsey than in Jersey, *viz.* that the majority of these structures are within sight of one another. Undoubtedly, in primeval times, such monuments were in existence on every headland round the coast; and it is possible that signal fires may have been used in connection with them. Most of these characteristic features are exhibited in the large cromlech on L'Ancresse Common, which stands on an eminence, called by the inhabitants of the Clos du Valle, Mont St. Michel, whilst the structure itself they call *L'Autel des Vardes.* Two photoxylographs are given of this interesting structure from different points of view (see Plate I., Figs. 1 and 2); but although the huge capstones are well shown, and the gradual diminishing of their size towards the east, still no outside view can convey any idea of the size of the chamber and passage beneath, in consequence of the sand and soil being so heaped up around the outside of the structure, that only the tops of the side props are visible. However, at the west end one may stand upright beneath the largest capstone; and when the soil was removed from the floor during the exploration of this cromlech by Mr. Lukis and his sons, the height of the western chamber was eight feet. The westernmost upright block is almost identical in size and shape with those blocks occupying similar positions in the cromlechs of the Creux des Fées, Mont Ubé, and the Pocquelaye.

On the north side of the L'Ancresse Cromlech, under the largest capstone, an evident disturbance of the pristine condition of the structure has taken place, one of the side blocks having been pushed outwards apparently, and smaller stones added, so as to form a supplementary kist, in which human remains were found, indicating a secondary interment. It would take up too much space to detail the relics found at the excavation of this structure; it is sufficient to mention that they were all attributable to the Stone age, and have been fully described by Mr. Lukis in the Archæologia, and by Messrs. Worsaæ and Thoms.

Divergent from the partially-destroyed circle which surrounds the cromlech are two paved causeways, leading in a winding track to the N.W. and N.E. Lines of Menhirs must probably have been associated with them. We cannot help noticing the similarity of some causeways observed by Capt. Parry in the Calthorp Islands in 1822, in connection with some deserted Esquimaux *stone galleried-huts*, amongst which human skulls, *lapis-ollaris* lamps, and glass beads, were lying about "*as usual.*"

"Leading from the huts towards the highest part of the island was a curious path made by the natives, two feet in width, and formed by removing the stones in places where they were naturally abundant, and where the ground was bare, by placing two regular and parallel rows at that distance apart. The only conjecture we could form respecting the use of this artificial road was that it might be intended for a deer path (those animals preferring a regular or beaten track to any other), by which means the Esquimaux might perhaps kill them from their usual ambush of stones."*

From the hill on which the great cromlech of L'Ancresse stands, other megalithic structures can be seen; for instance, in an eastern direction, and near the foot of the hill, are various blocks of stone, the relics of a cromlech, known from its position by a marshy pond as *La Mare aux mauves*, not far from which again is a portion of a stone circle, and some stone graves of the Bronze period. In the centre of the common is an interesting Kistvaen, consisting of a large oddly-shaped capstone (probably only a portion of the original stone), supported on several props. On one of these blocks are some barely-distinguishable cup-markings;† whether natural or artificial is mere conjecture. A Logan or rocking-stone once existed on a natural cropping out of rock to the eastward of L'Ancresse; the site still bears the name of La Rocque Balan.

---

* Vide Parry's 'Second Voyage,' p. 285.

† Since writing the above, the author has again examined those cup-markings, which, now that the lichens have been cleared out of them, present evident signs of artificial handiwork. They are nine in number, at the side and top edges of the N.E. prop.—S. P. O., February 4, 1870.

The cromlech next in importance to that at L'Ancresse, which it rivals in size, is that known by the name of Dé-hus or Du-Thus (Deuce), by some L'Autel du Grand Sarazin (see Plate II., Fig. 1). On examining this structure we see at a glance the large western chamber, with its huge capstone over 16 feet long, and weighing at least 20 tons. The second capstone, that next to the largest, is broken, and the fracture apparently took place during the period of cromlech-builders or their immediate successors, as the larger half of the stone still remaining *in situ* has been propped up by an additional stone pillar. In all there are eight capstones, which, with the side blocks supporting them, diminish gradually in bulk towards the eastern entrance, which is blocked up by a large stone, analogous to the L'Ancresse and other cromlechs. The narrow orientated gallery is conspicuous likewise, whilst the main body of the structure is divided into three chambers. The most noticeable features however, after all, in this cromlech, are the four side chambers, two to the north and two to the south; these are square and polygonal kists, some of which are entered from the eastern gallery, and others distinct, but all adjoining. In the chamber to the north and east were found two skeletons in a kneeling (crouching?) posture, the flat stone which covers the kist nearly touching their skulls. In the chambers to the south were found several layers of interments, the human bones being disposed in groups crosswise, with the skull on the top, indicating the corpses to have been placed in a sitting posture. There were pavements of flat stones between the layers of interments, which resemble exactly similar instances in the West Gothland tombs.*

As at L'Ancresse and in the other cromlechs of the Channel Islands, innumerable quantities of limpet shells were deposited for a depth of two feet throughout the structure, and various vases of ancient pottery-ware were disinterred; they are constructed of extremely coarse clay, worked with the hand, imperfectly baked, and some rudely ornamented, together with stone and bone instruments, clay beads (locally called Roulettes des Fées), amulets, &c.

Not far to the north-west of Dé-hus are vestiges of a kist, the capstones of which were destroyed against the wish, and in the absence, of the proprietor: this monument curiously enough bears the name of *Le Tombeau du Grand Sarazin*, a name in conjunction with a similar appellation given to Dé-hus, significant of the *Iberic* element, distinctly traceable in the ethnology of the Channel Islanders. A Dolmen, or *Trilithon*, consisting of a large capstone

---

* Nilsson on 'The Stone Age,' p. 149.

13 feet in length, resting on two props, and partly covered by the débris of a neighbouring quarry, still marks the spot where a large cromlech formerly stood in the same parish as the above-mentioned remains; the huge western capstone, *now destroyed*, bore the name of *La Roche qui sonne*. An analogous name to this Guernsey Memnon, *La Roque où le Coq chante*, another site in Guernsey, is mentioned by Victor Hugo in his celebrated work, *Les Travailleurs de la Mer*, in which he mentions the popular superstition concerning these remains:—"*Cette pierre est fort à surveiller. On ne sait ce qu'elle fait là. On y entend chanter un coq qu'on ne voit pas, chose extrèmement désagréable. Ensuite, il est avéré qu'elle a été mise dans ce courtil par les sarregousets, qui sont la même chose que les sins.*"

This cromlech is said to have been the largest in the island, and as the greatest part of the structure extended to the westward of the present remains, the largest capstone to the west must have been an enormous block; great superstition, indeed, attached to the broken portions of this structure. The farm-house of Belval close by was partly built of fragments from this cromlech, and shortly after the completion of its building it took fire and was destroyed. A vessel also sailing from St. Sampson's with *macadam*, from the same source, is said to have sunk. When the remaining portions were investigated, the proprietor is said to have looked on the *sacrilegious* proceedings with a terrified countenance, as if expecting that "Satan himself was about to be disinterred."

The fourth capstone at L'Ancresse much resembles the remaining capstone of *La Roche qui sonne* both in size and shape (a triangular prism), but is slightly smaller. The sole remaining impost of one of the Alderney cromlechs, *viz.* that at Tourgis, is in every respect similar also. This leads one to suspect that this stone was the fourth stone of the cromlech, and if so, the "*Roche qui sonne*" Cromlech would have been proportionately larger than the cromlech at L'Ancresse.

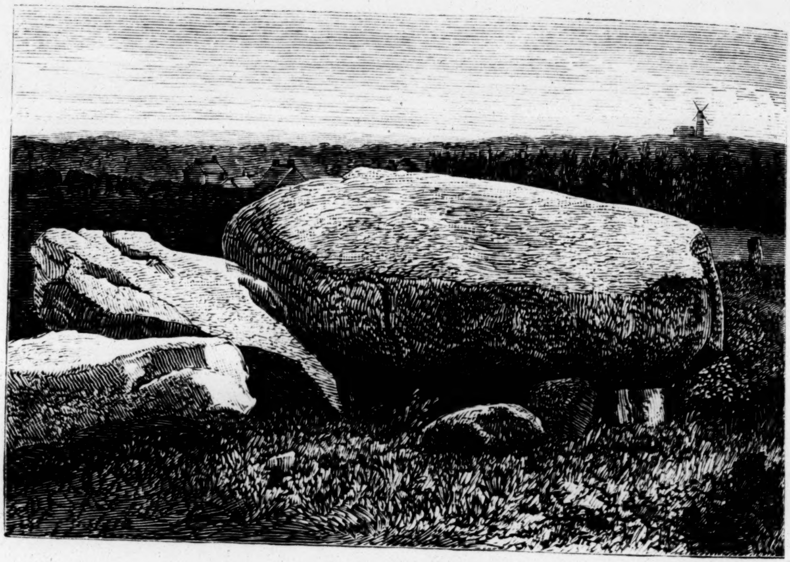
The last illustration accurately represents the present condition of a cromlech in the parish of St. Saviour, Guernsey, known by the name of the *Creux des Fées*, and which well exhibits the peculiar features of the French *Grottes des Fées* and *Allées couverts*. The western chamber is still covered in by a great portion of the original superimposed tumulus, and in fact forms a subterranean chamber or grotto, with the narrow passage entrance, now uncovered, but formerly covered with transverse slabs of stone resembling the *gang-graben* of Scandinavia. Only the two largest capstones remain, covering a chamber 21 feet long by 12 feet broad. This chamber has long been used as a cattle stable, and in consequence is not quite so sweet as might be. Here may be observed with advantage the usual method of filling the interstices between the

red by
here a
above-
d, bore
o this
site in
work.
opular
fort à
er un
ite il
s, qui

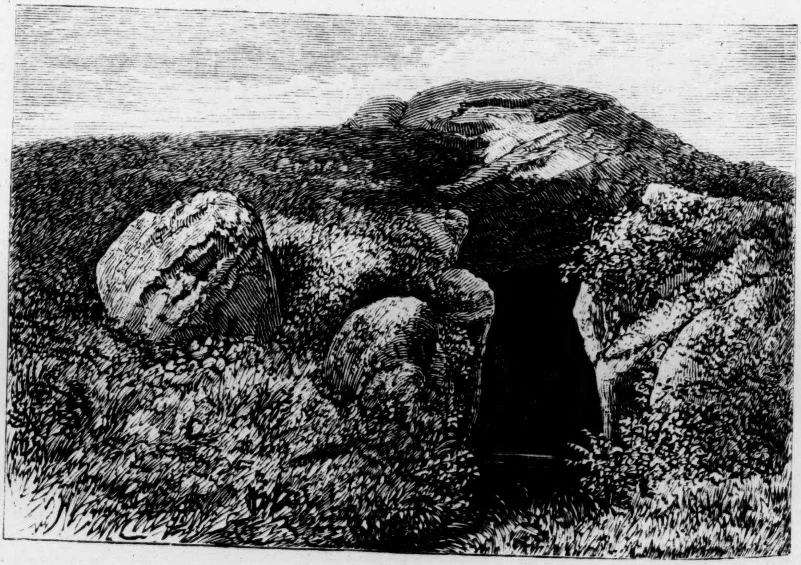
, and
d of
have
the
close
rtly
ved.
the
ons
the
ng

in-
(a
ng
in
is
e
n

n
e



1.—L'Autel Dé-hus.



2.—Creux des Fées.

larger blocks with smaller stones, to keep out the soil of the surrounding tumulus. The narrow entrance shown well in the accompanying photoxylograph (Fig. 2) is only 2 feet 6 inches broad. The two stones where the threshold formerly was are 4 feet 6 inches in height. The western upright slab is 6 feet in height, and of the same breadth. The plans of all these cromlechs should be compared with one another and those in Jersey; they may be found by those who care to inquire further into their original construction in the 'Journal of the Ethnological Society' for April, 1870, to which the reader is also recommended to refer for details concerning the other cromlechs in Guernsey; for in an article of this description it is impossible to enter into details of the numerous pre-historic remains yet extant in the bailiwick of Guernsey and its dependencies. The chief and most noted may be briefly enumerated as follows—*viz.* Le Trépied Cromlech, the Menhirs of *La Pierre Longue* and *Le Crocq* (La Pierre pointue, La Chaise au Prêtre, and La Rocque Magié have disappeared before the blast of the quarrymen), and the *tumuli* or *Hougues* of *Hatnée* and *Fouqué*. Putting aside the pre-historic remains in Alderney, Herm, and Sark, which fully deserve a paper to themselves, and which all carry out the generic resemblance to the galleried tombs of Scania, in Gothland, it is best to proceed to describe one or two of the principal Jersey cromlechs, in which the characteristics mentioned are fully exemplified. Three views of these remains, *viz.* two cromlechs, those of Mont Ubé and the Pocquelaye, with Le Quesnel Menhir, will be found in a recent number of the 'Illustrated London News,' January 15th, 1870.

The most important of the Jersey cromlechs is undoubtedly that one named the "Pocquelaye," near Gorey Harbour, Jersey; the only visible portion twenty years ago was the largest capstone, the sustaining props and other stones being entirely hidden beneath the remains of the tumulus. About the year 1848 excavations were made by Mr. Fauvel, and it was then discovered that this large stone formed the covering of a chamber of nine side blocks arranged in a horse-shoe form, whilst this chamber was again divided by partition-stones forming a smaller kist, a separate grave as it were, within a tomb. Further excavations were made, and five or six more chambers were discovered to the eastward of the first-mentioned. One chamber alone on the north side had a capstone *in situ*; this capstone was thrown down by the treasure-seeking proprietor, but is now restored as nearly as possible to its original position. Other blocks of stone were also thrown down at the same time, but have been replaced; great doubt unfortunately must always attach to any attempted restorations of such structures. Remains were found, but unfortunately no proper records of their position in the catacomb exist, whilst the pottery, relics, and stone implements associated with the human skeletons were sold to the British Museum, where they now are.

The narrow eastern gallery is well exhibited in this example, as also the remains of a double circular stone wall not dissimilar to that at L'Ancresse, but if anything of a larger diameter. Four upright stones now standing between these stone walls may have formed a portion of a peristalith, but unhappily there is a want of trustworthy evidence as to their really being *in situ*, as the walls and remains generally have been meddled with to such an extent that it is well-nigh impossible to separate the modern restoration from the original design.

The Couperon Cromlech in the same parish as above (St. Martin's) was formerly a gem in its way, being a small stone (Jersey conglomerate) structure of two parallel walls covered with capstones, with an oval peristalith surrounding it. Sad to relate, only two capstones were actually *in situ*, and the other stones scattered; still worse, however, these stones have been rearranged, and the remains cooked up to form a modern restoration of a prehistoric sepulchre. One of the present capstones (the fifth) is manifestly part of an upright which formed half of a partition, as exactly similar hand-worked stones are found forming partitions (to allow of entrance) in the covered *allées* of Brittany, and have been specially noticed by Mr. Lukis.

The cromlech of Mont Ubé, although devoid of its capstones, is still most instructive, being remarkable for the regularity of its form, which exhibits the original plan of the (Celtic?) architects, perhaps more perfectly than any other cromlech in the Channel Islands. This cromlech is more fully imbedded in the soil than the denuded remains of the Pocquelaye and Le Couperon, which may tend to its ultimate preservation. It consists of a large western chamber elongated towards the orientated narrowed passage, and is divided into several chambers. Two of the upright stone pillars which separate the cists have been worked into somewhat obelisk-like forms, perhaps to adapt them for the reception of an imposed capstone. It is much to be regretted that several important stones have been removed from this cromlech.

The fourth cromlech in Jersey, only explored last year, appears to have the form of a covered avenue, but no large western chamber has yet been excavated. Several cinerary urns were discovered more or less perfect, besides a small stone amulet drilled with two holes, a few flint flakes, &c., with traces of charred ash and indications of osseous interments. This is the only case on record in the Channel Islands where no layer of limpet shells (although within a hundred yards of the sea) has been found. From this fact Mr. Lukis infers that the interments were not of the primary dolmen-builders. Some years before, some bronze celts were found in this neighbourhood. The best Menhir in Jersey is a fine monolith called *Le Quesnel;* another, named *La Pierre Blanche,* is to be found not far from the Mont Ubé Cromlech. Under a flat Dolmen near Corbière Point, named *Table des Marthes,* some bronze weapons were found by M. Ahier many years since; but there is great doubt as to this stone being connected with the other megalithic monuments. Lines of Menhirs have been found in Greenland, where they appear to have been mainly erected to serve as landmarks during snowstorms, and some at least lead from the remains of huts to the nearest water. Capt. Parry notices, after remarking upon the remains of some stone-built Esquimaux huts, "We also passed a singular assemblage of flat stones set up edgeways, each about three yards apart, and extending at least five hundred yards down to a small lake situated in a grassy valley.*

The study of pre-historic archæology has now become a recognized scientific movement, but it may be remarked that, whilst the stone implements, ornaments, pottery, human and animal remains and interior "*finds*" generally have been assiduously collected in national and private museums, the cromlechs, sepulchres, and barrows containing these articles have not yet received their due amount of public attention. In all collections of pre-historic relics, which ought always to be *local* in order to be really instructive, there should be models (to scale) of the structures and localities in which the relics were found. No remains should be suffered to be taken away from the neighbourhood of the "*find;*" casts and facsimiles would answer the purpose in the national collections. The Rev. W. Lukis says "that the principal if not sole object of some investigators appears to be the possession of the articles which have been deposited with human remains. The object of the archæologist should not be the mere gratification of curiosity nor the accumulation of ancient works of art. A museum of antiquities is comparatively worthless if the history of the discovery of each particular specimen is not accurately known and recorded; these examinations should be made with the sole view of throwing light upon a dark period in the history of those who have previously occupied the soil."

This same gentleman has been so convinced of the necessity of examining and comparing the megalithic structures in Europe that he has spent four summers in Brittany, and (sometimes with the assistance of Sir H. Dryden) made accurate plans of the circles and avenues of Menhirs at Carnac, and throughout the Morbihan district. In his lectures on these structures Mr. Lukis draws attention to the fact that these lines or *Parallelíths* are universally orientated, and that they all terminate in circles at their western extremity; whilst the bulk and height of the Menhirs diminish gradually, and the widths of the avenues also diminish towards the east. He says, "There is a feature that is common both to groups of rows and to the sepulchres which may help to throw some light on the subject, *viz.* their orientation. By far the larger number of the sepulchral monuments, those I mean which are usually termed Dolmens, have their openings or entrances between the east and south points of the compass, *i. e.* nearly 90 per cent. are so turned, which it must be admitted cannot be an accidental circumstance. So too all the avenues are similarly orientated. If therefore the builders of the tombs had a religious reason for this arrangement, that same reason must have been dominant in the minds of the constructors of the avenues, and the inference is not without force that the same people erected both. There are *few* circles of stone *not* attached to avenues in the Morbihan."

---

* Parry's 'Second Voyage,' p. 62.

It is in China, however, that chambered tumuli associated with megalithic avenues have attained, if not their hugest, their most elaborate development, in consequence of an ancient acquaintance with iron and steel tools. Thus we read that the great tomb (the "Ling" or resting-place of Yung-Lo, of the Ming dynasty), thirty miles from Pekin, consists of an enormous mound or earth barrow, covered with trees; its height is not mentioned, but is evidently considerable, from the fact that the circular wall which surrounds it is a mile in circumference. In the centre of this mound is a stone chamber containing the sarcophagus, in which is the corpse. This chamber or vault is approached by an arched tunnel, the entrance to which is bricked up. This entrance is approached by a paved causeway, passing through numerous arches, gateways, courts, and halls of sacrifice, and through a long avenue of colossal marble figures, sixteen pairs of wolves, kelins, lions, horses, camels, elephants, and twelve pairs of warriors, priests, and civil officers. Whether this avenue is orientated or not is not mentioned. An idea may be formed of the size of these marble figures from the following:—"During the building of the late Emperor Heen-fung's tomb a road 100 miles long was made from the quarries at Fang-shan to the Tung-ling, and a block of marble 15 feet long, 12 feet high and 12 feet broad, weighing 60 tons, was seen by several of us then resident at Pekin being dragged along this road, on a strong truck or car drawn by 600 mules and horses." . . . . "This block was to be cut into the figure of an elephant, to be placed as one of the guardians of the tomb." *

In order more fully to appreciate these pre-historic catacombs, and to comprehend the modes of their construction and the usages connected with them, we must follow Sir John Lubbock's example in comparing them with somewhat similar remains in use by modern savages; and we take this occasion to bring forward as suggestive and parallel examples the methods of sepulture as practised up to this day by the tribe of Hovas, the inhabitants of the mountainous plateaux in the interior of Madagascar. The Hovas begin to erect their tombs in early life, and make their completion through a series of years one of the most important objects of their existence, as an effectual means of being held in honourable remembrance by posterity. These tombs are family vaults or çatacombs, and in their construction an immensity of money, time, and labour is expended, limited solely by the wealth of the builder. In erecting a tomb the first consideration is the selection of an eligible site, publicity and elevation being the two principal requisites. Sometimes a tomb is placed immediately in front of the house of the person by whom it is built, so the tombs of the kings are within the precincts of the palace at Anantananarivo, the tomb of the first Radama being a conspicuous object in the palace yard. The site having been chosen, an excavation is made in the earth, and a stone vault made, the sides and roof of which are made of *immense slabs of stone, unhewn granite, flat at least on the inner side. Each side of this kist, sometimes seven feet high and twelve feet in length, is often formed of a single stone.* A sort of subterranean grotto is thus made, the entrance to which, always to the north or east, is closed by a large upright block of stone,* which is removed when a corpse is taken in, and fixed again at the termination of the funeral. In reading this, does it not remind one of our European kistvaens and cromlechs of the Stone age? This stone sepulchre is covered over with earth, and by means of stone copings gradually diminishing, presents from the exterior a pyramidal form. These structures, which we may call pyramidal tumuli, containing stone chambers, bear at all events a certain analogy to the chambered tumuli of western and northern Europe. Some of these structures measure 50 feet in length by 20 in breadth.

---

* W. Lockhart, 'Proc. R. G. S.,' 1866.

The large slabs used in forming these megalithic structures are usually of granite and syenite. The Hovas mark out the required dimensions of the slab by *odies* or charms (the idol-keepers being well acquainted with the cleavage of the rock, and taking advantage of this circumstance); large fires of cow-dung are made along the line thus indicated, and when the rock has become heated, water is dashed upon it, by which means, and with the help of long levers, large masses are detached from the mountain side. When the slab is to be removed, ropes of native hemp (rofia fibre, or the bark of the hibiscus, and a long tough grass are all used in the manufacture of cordage) are fastened around it, and amidst the vociferations of the slaves it is dragged away. In ascending a hill they place wooden rollers under the stone, and move them forward as it advances. Sometimes five or six hundred men are employed in dragging a single stone. A man usually stands on the stone acting as director. He holds a cloth in his hands, and waves it, with loud and incessant shouts, to animate those who are dragging the ponderous block. At his shout they pull in concert, and so far his shouting is of real service. Holy water is also sprinkled on the stone as a means of facilitating its progress, till at length, after immense shouting, sprinkling, and pulling, it reaches its destination. When the tomb is erected for a person deceased, but not buried, no noise is made in dragging the stones for its construction; profound silence is regarded as indicating respect. Sometimes a corpse is buried in a dwelling-house till the new tomb is finished, when it is removed to its final resting-place.

---

* Compare Nilsson, 'The Sunny Side,' p. 127; also Ellis relates that one of the Hovas requested his sons, shortly before his death, that after his interment they would occasionally remove the large stone slab that would form the door of his sepulchre, and let the sun shine in upon him.

The dead body wrapped in a red *lamba* is placed on a bier, and a grave is dug for its reception within the vault, which is not paved: the corpse is placed in the grave without delay, and covered with earth, so that it is a grave within a stone tomb: a quantity of *fresh charcoal* is placed on the body to resist rapid decomposition: the wooden bier is left within the tomb by the side of the grave. It is customary at the interment of any man of note to deposit large quantities of property in the tomb with the corpse, especially of articles to which the deceased was known to be attached; thus, at the funeral of the first Radama, six of his favourite horses were killed and buried with him, a brass cannon was burst and, with a cask of wine, also buried with him, besides 10,309 silver dollars and upwards of 1000 articles of personal property, jewellery, &c.

The tombs are sometimes enclosed with stone walls, and within the enclosure are often two or three large upright stones.

The Hovas also erect stone pillars not dissimilar to our *Menhirs*, some of which are of a considerable size: they have no marks on them, and are called "*fahatsiarovana*," i.e. *causing to remember*. A name is also given them, derived from their position, "*mitsangambato*," *an elevated stone*.

Mr. Lukis, in examining some of the cromlechs and kists in the island of Herm, near Guernsey, suspects that some were merely ossuaries; that the bodies had been subjected to maceration elsewhere, and their bones deposited where found; so, also, Sven Nilsson* tells us that the Rev. M. Bruzelius found in the Asagrafven gallery-tomb in Scania, a vast quantity of human bones, from which he was of opinion that the flesh had been stripped off before being deposited in the vault, as he found in one place only the bones of the extremities and no vertebræ and in another a quantity of skulls. A similar conclusion was come to by Mr. Boye in examining a tomb at Hammer, in Zeeland. I find some almost similar instances among the Hovas of the present day, which may serve to throw some light on the subject. In Ankova the bodies of lepers are carefully bound up and rolled or thrown into a grave dug in any unenclosed space; here they are left interred beneath the soil for at least twelve months, after which they are dug up, the *bones cleaned* of all the flesh, wrapped in cloth, and deposited in the family vault. Again, the Hova warriors are always anxious that their remains should rest in the ancestral stone vault, and it is customary for comrades on a campaign to pledge one another that should one of them die, the survivor is to obtain and convey the bones of the deceased to his relations. In such a case every particle of flesh is stripped off the bones, which are brought with great trouble from the scene of action, however distant. and given to the nearest relatives, and buried with due ceremony. When the body cannot be found, after a battle for instance, it is usual to erect a cenotaph. which consists of an unfinished tomb, *i.e.* the three sides of unhewn stones, the fourth being left open for the disturbed ghost to enter and repose. Is it not possible that some of the apparently incomplete kists were erected with similar intentions?

---

* P. 161.

The author noticed near Andevorante a tumulus on which were six upright conical stones about 6 feet high, which had been erected in memory of six Hova officers who died or were killed during Radama's campaign against the Betsimasarakas.

Before leaving the subject it may be as well to allude to the vestiges of the Vazimba, the supposed aborigines of Madagascar. These vestiges consist of small tumuli, or rather cairns, surmounted by an upright stone pillar, and are generally overgrown with thickets. These graves or altars are regarded with superstitious fear by the natives, both Hovas and other tribes: they occur in Ankova and in the western portions of Madagascar. These Vazimba are said to have been dwarfs, and are described by Rochon under the name of Kimos, and supply the same part in the Malagasy legends that the Lapps do as pigmies in the northern Sagas. There is little doubt that these Vazimba were the Hovas themselves, who, although not diminutive, are below the average stature, and who in colour, intelligence, activity, industry, courage, manufactures, and habitations, are exactly what Rochon describes the Kimos to have been. Like the Trolls and goblins of Scandinavia, the Vazimba have two characters; they are sometimes malicious and spiteful (*masiaka*), at other times benevolent and grateful (*masina*). It is curious that both in Europe and in Madagascar the pre-historic tumuli should be referred to these dwarfs and elves; thus in Sweden we have goblin caves and pigmy hillocks, and in the Channel Islands we have Pocquelaye, Creux des Fées, &c.

A few words about the stone-celt as associated with the presumed cromlech-builders of these islands may not be out of place here. These celts comprise all chipping or hewing stones, *Tilhugger steen*, which, according to their various modifications, may have been hatchets, axes, chisels, adzes, or wedges, and have been found generally throughout the islands in such numbers as serve to show how universally they were used as domestic implements in pre-historic times. They all belong to the Neolithic period of the Stone age; nor is it probable that any of the Palæolithic flints would be found on a granite island where little or no alluvial soil or drift gravel exists.

Mr. F. C. Lukis supplies me with the following list of celts, in his private collection, which he has obtained in the bailiwick of Guernsey (which includes Alderney, Sark, and Herm) alone, with the parishes in which they were found:—

Le Clos du Valle	33	Guernsey.
St. Sampson et l'Epine ..	46	
Ste. Marie du Castel	22	
St. Andrew's	21	
St. Pierre-Port	11	
St. Martin's	9	
St. Sauveur	6	
St. Peter-in-the-Wood ..	2	
Torteval	3	
Forest	2	
	155	
Herm	5	
Sark	25	
Alderney	12	
Total	197	

In round numbers 200. It must be remembered, however, that this list does not include *fragments* of celts, great numbers of which have been collected.

It will be seen from this list that the greatest number of these celts have been found in the parishes of St. Sampson and the Vale, that is, in the northern part of the island. Perhaps this may be accounted for by the circumstance that, prior to the year 1808, a large moiety of both these parishes was cut off from the main island at high water, and therefore less accessible; consequently even now there is more open common and waste ground, with less cultivation, than in the rest of the island. So also there are more cromlechs extant, and it is possible that their sites were chosen in this remote locality on account of its partial inaccessibility.

As to the celts, however, they are of all sorts and sizes, as observed above, and singularly enough the materials of which they are composed are not always native, as might be expected, but, on the contrary, are as often as not foreign, not only to these islands but to France and even to Europe occasionally, so that we are led to the conclusion that these instruments have been imported from great distances.

It is just possible that such implements may have accompanied immigrations of nomadic tribes (Indo-Scythians ?) from beyond the Caspian Sea, but at the same time they may have been exchanged or bartered, and thus have found their way so far west as Brittany. It appears evident that there was some commerce in such tools and weapons, which must have been highly prized, as many bear undoubted marks of having come from the same locality if not from the same *manufactory*. I use the word *manufactory* advisedly, for it is almost certain that at particular spots in Europe (where favourable geological formations gave ready access to valuable material, such as quartz, serpentine, porphyry, jasper, granite, greenstone (diorite aphanite), steatite, actinolite, flints, chert, agate, &c.), great numbers of celts were manufactured by the resident tribe, and exchanged with the neighbouring tribes for food, peltry, &c. Nilsson shows from glass beads being found among similar remains that the savage aborigines of Scandinavia had commercial intercourse with more civilized nations.

There is one peculiar celt made of a scarce mineral substance to which I must allude, as its presence in this part of the world seems unaccountable. It has never been particularly noticed, as far as I know, by any archæologist except Mr. Lukis, who long ago remarked upon it, and great interest must attach to it. I mean the celt made of *Fibrolite:* celts of this material have been found throughout France, the Channel Islands, and in England, and doubtless (although I have not seen any of the continental collections) throughout Europe; I am almost certain that there is one in Col. Lane Fox's collection from the River Irawaddy, and if so, that one came from much nearer its original home than those found here, for it is not known where any of this substance occurs in Europe; indeed, the nearest spot where it is attainable seems the *Carnatic.* If I am right in the above surmises it opens out a pregnant field for investigation. Similar observations apply with regard to the Jade* instruments, which are found in the Lake-villages of Switzerland. I may say that M. Schlagintweit relates the curious circumstance that Oriental jade-stone, when first taken from the quarries, is comparatively soft, not acquiring its extreme hardness until some time afterwards. The vulgar name for the celt among the peasantry of the Channel Islands is "*Coin de Foudre*," as it is "*La Pierre de Tonnerre*" among the French countrymen, and the *Thunderbolt* of our English common-folk. The Swedes also, in common with the Irish, Scotch, and Welsh, have the same superstition as to their electrical origin. It has ever been a source of inquiry as to the spot where it (the celt) could be picked up after a thunderstorm; this idea has been confirmed in

* See Sir John Lubbock's 'Pre-historic Times,' p. 134, on the presence of nephrite in the Lake-dwellings.

Guernsey by numerous examples occurring, in which celts have been found immediately after thunderstorms, the fact being that it is only after thunderstorms that the people look for them. Some years ago the signal staff of the *Guet du Câtel* watch-house was shivered by lightning, and shortly afterwards a man in the same neighbourhood picked up close by a flint celt, measuring 6 inches in length. He was in the habit of chipping off little bits, and, applying the instrument to his nose, discovered the peculiar smell (well known when two pieces of flint are rubbed together), which he conceived, very wisely, proceeded from its mystical fire origin in the clouds. Among the common people the celt is supposed to have supernatural powers, and to have the virtue of preservation from injury.* It is often placed in the masonry of a house to preserve the same from lightning. Mr. Lukis is in possession of several, which have been obtained from old walls. They have been known to be kept on board of merchant ships, in the captain's cabin, for the same purpose. Mr. Rose tells us that the stone celts are highly valued in Denmark as charms, so that it is difficult to induce their possessors to sell them, as they were thought to bring good luck to the house. There is also an instance mentioned in which one of these ancient implements was found concealed under the floor of a cottage, near the door, having been placed there to keep out witches. In the Grecian Archipelago few cottages are without one of these stones, which is supposed to possess some sanitary virtue; the possessor breaks off a small portion of it when required, and either keeps it as a talisman against some particular malady, or dispenses it to his friends for the same purpose.

"One great source of danger to which this innocent implement is exposed is the fact of its being supposed to be thrown to the earth by fairies and hobgoblins. The old inhabitants of some of our islands, when they found one on their premises or fields, would immediately smash it to powder upon some stone. A Jersey gentleman has informed me that when he was a lad he had seen many treated in the same manner. Some years since I (Mr. Lukis) obtained a celt from a countryman of this island (Guernsey), and there arose a fearful storm of lightning and thunder in the night. On the following morning both husband and wife appeared at my house begging me to return the celt, as they had not slept a wink the night before.

"In Brittany the *Moen-sourous*, as the celt is called, is often thrown down into a well or spring as a purifier of the water. One well in the Morbihan is known to have had as many as five of those instruments thrown into it. In Switzerland the mountaineers are in the habit of wrapping one round the neck of the bell-wether, as a preservative against the foot-rot. We (Mr. Lukis and his sons) have obtained about a dozen from these shepherds."—Fred. C. Lukis.

---

* Compare Nilsson on 'The Stone Age,' chap. vi., pp. 199-202.

Who or what this ancient people were who have left behind them their cromlechs and circles, Menhirs and tumuli, whether they are the same people who used these stone implements, yet remains undecided; but considering the remarkable results which have already been arrived at from archæological investigation, which, as far as the examination of pre-historic vestiges, dates only from the commencement of the present century, we may be sure that approximate, if not certain, conclusions will be arrived at sooner or later, especially when that important branch of ethnology, namely, craniology, shall have been fully developed by the successors of Retzius.

II. ON INSANITY.

By Dr. P. Martin Duncan, F.R.S., &c.

It is very remarkable how long a time it takes to disabuse public opinion of ideas which are founded upon the slightest evidence. The pertinacity with which such ideas are held generally originates in there being some palpable truth connected with them that hides some very unpalatable errors. Such a truth is all the more secretive when it refers to things which are to the credit of humanity, in contradistinction to those which mankind willingly forget as uncomfortable subjects. Thus there are some very general ideas current that the human race is advancing in mental power, that the diseases of the mind are not increasing, and that the Lunatic Asylum system is highly satisfactory on account of the cures perfected under it,—which have their origin in partial truths that have been carefully fostered, while the errors which make many inquirers demur have been shut up as social skeletons in the national closet.

The spread of literature and the increased facilities for national intercourse, the rarity of public exhibitions of the insane, and the acknowledged comforts and expensive surroundings of the unfortunates in asylums are patent truths which lead the superficial public to believe in the advance of education, the progress of that practical Christianity which is the test of civilization, and the surpassing excellence and usefulness of the lunatic asylum. The real truth sooner or later breaks upon men; and just as the present outcry for education is a proof of that want of it which has been protested against for years, so a murmur of discontent often heard of late is indicative of the commencement of the change in opinion, which must progress, about the origin of insanity, its relation to civilization, and the success of the present system of curation, which is fenced about by commissioners, the law, a staff of well-educated medical superintendents, a few alienist physicians, and protected by the inertia of the English mind and by a good amount of the "rest and be thankful."

It is quite time to survey the curious opinions that have retarded the correct treatment of the insane, to notice what relation the increase of the disease bears to physical rather than to intellectual strain, and to show how unsatisfactory are the results of the great and expensive Asylum system in this country.

Probably there is no subject upon which non-professional people are more ignorant than that of mental alienation. There is nothing which speaks more loudly to their fears, and they consider insanity the direst calamity that can afflict humanity. It is usually looked upon as a mental death, as a condition which taints the family for generations, and which, if remedied for a time, is constantly on the point of recurrence. The curability of madness, and indeed its recognition as a disease within the ministry of man, are matters productive of much discussion amongst well-educated people, and there does not appear to have been much advance made by the public mind towards exact knowledge upon them.

There is nothing more evident than the thorough desire to do evil which is evinced by the majority of madmen, and the exceptions are so rare that they are popularly ascribed to the unusual amiability of the afflicted. Simple delirium which accompanies many ordinary complaints is constantly cited as a phenomenon which permits our evil nature to become manifest in spite of ourselves, and the indefinite nature of the current ideas upon the character of mental aberration influenced by these thoughts receives greater eccentricity when arguments are founded upon the ravings of the sufferers from delirium tremens. The horrible visions, the malicious mischief, the foul language, and the abject fear of the images floating before the eyes, so commonly illustrated by ordinarily quiet men under the influence of poisoning by stimulants, taken into consideration with the usual phenomena of insanity, present a series of dilemmas to those who will not hear of any intimate connection between the mind and the material body. Out of these difficulties there has ever been an easy path; but it is to be hoped that it will soon be closed by that Christianity which prefers to accept the conscientious labours of truth-loving men as its supports rather than incomprehensible dogmas. The bridges over the old road out of the dilemma were witchcraft, and the action of the moon and the devil. The first of these has broken down, and the influence of the idea of absolute possession by evil spirits has almost ceased, but not quite, to operate. Amongst the uneducated labourers of some of the eastern counties witchcraft is still an object of terror, and only a few years since, a crazy woman was considered "bewitched," and had to be protected from the violence of her fellow-villagers by the law.

Formerly all Europe considered the devil a better entity than the philosopher who insisted upon a connection between the physical condition of the brain and the immaterial mind. It appeared to be a solace and a comfort to have that evil presence at hand to demolish the pretensions of fellow-men; and as it has ever occupied a prominent position in the religion of the northern branch of the Aryan family, there was something almost sacred, with a tinge of goodness, in advocating its positive powers upon the minds of men, some of whom had led the purest and holiest of lives before their day of mental decadence. When priests went mad, it was hardly the thing to refer to the object of their constant antagonism. Profane men were known to jeer at the bell-ringing and holy-water splashing, and the general paraphernalia of exorcising, which were persisted in under the circumstances; but they were few in number, and public opinion, which would not admit any connection between the body and the mind, had no compunction about the spirituality of bronze, tallow, and water. Philosophers who desired to be orthodox shielded themselves under the influence of classical learning, which, being incomprehensible by the mass, was dearly loved by the few, and therefore universally reverenced. They quoted the myth which made Bacchus a mind-destroying god, and thus joined with the multitude in ascribing the seizure to some agency beyond the pale of materialism.

The occurrence of what has been called demoniacal possession being testified to in Holy Writ was never doubted, and the Scriptural proof of the Satanic origin of mania was strongly insisted upon by the clergy. Any attempt to deny this proposition was met with the usual charge of infidelity; and the suggestion that the possessed by devils were only so afflicted according to the prevailing method of scientific thought, and that it was a *façon de parler*, called up scornful accusations of atheism and freethinking. Priests and people stood up manfully for these Satanic rights, and it is really wonderful that the commissioners for the protection of the insane are not associated with some title which refers to the old popular idea of the origin of the affliction. They, however, bear witness to a popular belief which, after a sharp struggle, overthrew the diabolical theory to a great extent, for they are called "Lunacy" Commissioners.

Artemis had most varied relations with mankind. She was the assistant at his birth, she assuaged pain, blessed his industry, hunted him down when she was sporting, was insensible to the allurements of love; and the well-formed huntress and mistress of rivers liked to be propitiated from the time of Iphigenia with the blood of human sacrifices. She took to herself the attributes of Selene, and claimed the night-driven chariot. Medieval ignorance gave her moon, certainly a very material body, a very decided power over the demented. The full moon, so studied by witches, was considered to be singularly pernicious to those whose minds were gone. So fast a hold did this opinion take, that, having a greater or less origin in an old myth, and belonging to the category of witchcraft and demoniac notions, it lasted, and has persisted, at least in name, until the present day. Moon-struck people are lunatics, and are under the care of Commissioners in Lunacy At present English science is committed officially to the belief in the lunar theory of insanity, just as it was formerly to the witchcraft and diabolical ideas. People still believe that the insane are worse at the full of the moon; and if the ideas of the multitude concerning the causes of madness are examined with a little critical care, it will be seen that they are founded upon the notions that bridged over the dilemma, and upon a curious opinion which brings the Great Ruler of all things, as the punisher, in immediate connection with the suffering mortal. The mind makes the man, and brings him in relation with his Creator. The perfect immateriality of the mind and its entire independence of the body being common beliefs, the particular influence of the Deity upon perversions of it is readily accepted as a necessary sequence.

Everyone must admit the overwhelming nature of the calamity of insanity, but modern science has proved that it ought to be as curable as other afflictions, or rather that a great proportion of the alienated ought to return to their former healthy condition of mind.

The influence of moral management and hygiene in increasing the number of recoveries in acute mania, and in shortening the duration of attacks, is perfectly evident, so that the ministry of man has much to do with restoring the alienated. There is no doubt that many become insane, and often incurably so, in consequence of long-continued moral and physical sins, and such cases come under the argument so ably elaborated by Bishop Butler. They prove that "there is a kind of moral government implied in God's natural government." Many suffer for the same natural sins, but not in the mind, and become hopelessly diseased in important organs. One class is as bad as the other, and yet in one series of cases the mind is affected, and in the other the mind is clear, the body being diseased. The immediate nature of the punishment can thus hardly be sustained, and we are forced to recognize its influence as operating secondarily and through certain definite physiological forces. These stand up like the tower of Siloam, and preach much the same sermon to the lookers-on. Were it not so, the ministry of man would be in direct opposition to the Creator's will, and the cures which follow the treatment of that insanity which has been produced by immorality and physical neglect, would be anomalies in the scheme of the government of the universe.

The Asiatics reverence insanity just as they do idiocy, and sufferers from it have been privileged since the days of David.

The demented and maniacal are not considered to be the victims of witchcraft, and to be persecuted by the Evil Spirit, nor are they supposed to be under the influence of the moon. The immediate influence of the Higher Power is invariably recognized, and no thought is given to anything like the production of insanity by physical disease, degeneracy of constitution, and hereditary taint.

The practical North Americans as a body—of course the highly educated are not included—either hold the indefinite opinions which characterize the thoughts of the corresponding public in England upon insanity, or would seem to believe, as English people did formerly, that the maniac is responsible for his violence and unreason, and that it does not much matter how he is treated, so that he is secluded. Even a curious kind of insanity is admitted to exist, which can be traced to have its diagnosis decided by offences against the former national proclivities. Thus an alienist physician living in the Southern States before the great war, described a species of insanity which affected the negroes. He compounded a name out of two Greek roots, which signified the bolting mania. The comforts and moralities of slavery were so well adapted for the African people, that the constant attempts at escape could only be looked upon as an evidence of insanity in the race which is so free ordinarily from psychological affections!

The treatment of some insane people in not very remote districts may suffice to prove that the Yankees have very materialistic notions about the disease, and that they do not hold the Asiatic opinions.

In 1868, Dr. Alexander Robertson visited the New York City Lunatic Asylum, and found that on the 31st December, 1867, of the 895 patients in the asylum, 304 slept on the floor, there being only 591 bedsteads in the wards. He writes:—"I was convinced that there is not sufficient room even for these (beds), as they are too near each other. Many of the bed-rooms are small and dark, having no windows, and are dependent for light and air on small openings into the corridors. In a large proportion two patients sleep together, and as the rooms only contain about 700 cubic feet, it is clear that the atmosphere must become very oppressive during the night, more especially in hot weather, such as at my visit, when the thermometer was standing at 100° Fahrenheit in the shade." There is about one homicide committed every year in these rooms. Strait-waistcoats, leather wristlets, and bed-straps to tie patients down in their beds, are part of the usual comforts of this disgraceful hole. Dr. Robertson sums up with—"Much disorder also prevailed in a number of the wards of this part of the establishment, many of the patients being stretched on the floor of the halls, some excited, others in a listless, moody, or apathetic state. Their position, however, seemed very much a matter of necessity, as there was apparently not a seat for each, had they been all anxious to sit down at the same time. Both there and in the 'Separates,' a large number were barefooted, and their clothing was untidy and ragged in the last degree. I noticed a man in one of the halls nearly in a state of nudity, his breast uncovered, his feet, legs, and fore-arms bare, and the clothing he had on hanging in tatters about his body, thighs, and upper arms. No remark was made about his condition, and it did not seem to attract attention as in any way extraordinary. As I have said, great excitement prevailed, more especially in the wards for the acute and violent cases. Never, in fact, have I visited any institution for the insane where the noise and confusion were so bewildering, nor where I experienced the same feeling of relief on leaving." The river runs by the asylum, and is supposed to check escapes, but suicides by drowning are "rather frequent." Four in six months was considered a favourable average!!! Scurvy frequently occurs amongst the patients, and four years since a large number died from typhus fever, and two years ago seventy died from cholera. The arrangement for religious exercises is most complete; three clergymen of various persuasions, and lay assistants being on the rota. The management of this outrage upon Christendom is by the Board of Commissioners of Public Charities and Correction, consisting of four members, who have been denounced by Dr. Beecher in his best strong language.

Dr. Willard published a report at the desire of Congress in 1865, and his opinion of the asylum was "that it was large and well conducted." . . . But, fortunately for his reputation, he had described others in the most straightforward manner, and, compared with them, the City Asylum was indeed superior. He notices that in Broome County Poorhouse "whipping is seldom resorted to" (for the insane). Columbia County Poorhouse: the great majority (all lunatics) are noted as filthy. Twelve sleep on straw, without bedsteads. The straw is changed once or twice a week. None had stockings during the winter. Portland County: the sexes are not kept entirely separated, and male attendants are employed to care for the female insane. Delaware County: the report, after describing the wretched cells, goes on to say,—"The sufferings of these unfortunates, from whom air and the light of heaven are shut out, would form (he might have written do form) a dark chapter of human misery, could it be written." Niagara County: "The whip is sometimes, though rarely, used to enforce discipline." St. Lawrence County: "Though no restraint(?) is used by handcuffs, whipping is resorted to, and the violent are put in cages to subdue them." Saratoga County: "Corporal punishment is administered to men, women, and children" (the latter remark apparently refers to sane paupers as well as lunatics). Tioga County: "They are seldom if ever visited by a physician." Green County—"Six lunatics are confined in cells, five of them are in chains, including two women. Some are chained to the wall. They are in a wretched state, and none are cured or improved. In conclusion, the following quotation of Dr. Robertson from Dr. Willard's report may show the opinion of the Executive of the United States, that is to say if opinions infer conduct, upon the *status* of the insane:—"In some of these buildings the insane are kept in cages, in cells dark and prison-like, as if they were convicts instead of the life-weary, deprived of reason. They are in numerous instances left to sleep on straw like animals, without other bedding; and there are scores who endure the piercing cold and frost of winter without either shoes or stockings being provided for them. They are pauper lunatics, and shut out from the charity of the world, where they could at least beg shoes. Insane in a narrow cell, perhaps without clothing; sleeping on straw or in a bunk, receiving air, light, and warmth only through a diamond hole through a rough, prison-like door; bereft of sympathy and of social life, except it be with a fellow-lunatic; without a cheering influence or a bright hope of the future: can any picture be more dismal? and yet it is not overdrawn."

In Rome the picture may almost be drawn over again, and in fact wherever the influence of the intellectual classes is swamped by the masses or by an uneducated legislature. We, as a nation, have issued from this reproach hardly fifty years. It is still usual to connect lunacy with an indefinite something which implicates Providence and the dependence of the mind upon cerebral action, due reservation being made that there is nothing material between them. The present system of the treatment of the insane is founded upon these remarkably indefinite ideas, but it is a satisfaction to find that even the Commissioners in Lunacy, who originate with the Keeper of the Queen's conscience, have at last had the courage to associate mental perversion with physical decay. Let us notice how some old facts carry out their opinion.

It is excessively difficult to come to a satisfactory conclusion respecting the amount of insanity and its kind in uncivilized races, and also in those nations where civilization differs materially from our own. The most savage races do not come sufficiently in contact with accurate observers for a correct estimate of their freedom from mental disease to be formed, and the low type of their reasoning powers may oftentimes not render delusion and mild dementia prominent mental conditions. It is rare that any unusual strain is placed upon the minds of such savages; but when it occurs insanity appears not to be uncommon. Thus, some of Livingstone's faithful followers, who traversed the continent of Africa from west to east with him, were evidently rendered insane and suicidally so by the excitement consequent upon visiting residences of Europeans and shipping. The occurrence of insanity in any of the African races is said to be very rare; but there is plenty of evidence that the negro slaves suffered considerably from several kinds of insanity, and their offspring also. This is also true for the slaves derived from other dark African races, who are not true negroes. Idiocy was frequent amongst the descendants of the imported negroes, and a low type of perfect intelligence, which was often perverted, was common, but was difficult of distinction on account of the mechanical and automatic action of the life of the slave. Drs. Bucknill and Tuke quote the testimony of Dr. Moreau in reference to insanity in Egypt. He found an asylum for the insane at Cairo,* but at Alexandria, where there was a population of from 80,000 to 90,000 inhabitants and many general hospitals, there was not even a ward assigned to the insane. He asserts that, on the authority of Dr. Gregson, surgeon-in-chief and resident in Egypt for nearly ten years, that insanity is very rare. The Doctor only saw one example of the disease in that period. Dr. Moreau says that as the civilization of Egypt is left behind and the Delta becomes more distant, lofty mountains and desert plains, tents and cattle, successively replace cultivated and fertile fields, habitations and bazaars. With the soil man becomes more degraded, his intellectual activity diminishes, and is at last reduced to a minimum, absorbed as he is in the necessary wants of physical life. Among this population the insane become fewer and fewer in number. I have not met with a single one, not even an idiot, writes Dr. Moreau, in all Nubia. Several of my friends, he continues, who have visited Sennaar, Cordofan, and Abyssinia, have found only here and there a few imbeciles. The same testimony has been adduced with respect to the Guinea Coast. Dr. Moreau suggests, however, that many of the Santons are really insane, and recent travellers in Eastern Africa might almost say as much for the brutal chiefs of some tribes. Nevertheless the rarity of insanity amongst the African populations appears to be established.

Dr. De Forest, of the Syrian Mission,† says "that it is impossible to obtain accurate statistics of the insane here; but I think the disease far less frequent than in our own land." There would appear to be more insanity amongst the Syrians than amongst the African races, the Syrians being a very mixed race. Insanity is said to be less frequent amongst the inhabitants of Bengal and less acute than amongst the civilized races of Europe; but its admitted increase is accounted for by the introduction of European vices. Polynesia appears to be comparatively free from insanity; and its natives, with those of the Australian and New Zealand islands, have received accessions of the disease simply through their contact with the worst parts of our civilization. The Chinese and the races associated under that name, and which constitute so large a proportion of the population of the world. are said to be remarkably free from mental diseases, if the prejudicial effects of opium be not considered. The majority of the cases of insanity observed by European physicians in China had their origin in opium smoking; and it is generally admitted, although the opportunities for a close examination of the question have been very slight, that mania and dementia are rare there. No country has passed through more exciting scenes during the last twenty years than China; and rebellion, wholesale massacres, wars with Europeans, and great social changes must have produced their exciting and depressing effects upon a race which is singularly domestic in its affections, much more industrious and saving, and more learned than any other of the Asiatics. The amount of insanity in this great empire can really not be estimated even approximately. In considering the question, some of the peculiarities of the race must be remembered. The ready disposition to commit suicide which is common to the races on the mainland and to those of the islands, including Japan, the sale by men of their own lives for comparatively trifling sums of money, and the suicidal despair which readily affects Chinamen under severe disappointments and hardships when working in distant countries, indicate that the insanity of the people may take on very different phenomena to those observed amongst European nations. The sudden outbursts of murdering passion observed in the Malay race may be taken as an evidence that the great peculiarity of insanity amongst its members is violence, and that ordinary monomania is hardly to be expected.

---

* Some years since the lunatics in this asylum were treated just like wild beasts.

† See Bucknill and Tuke, page 49.

There is some amount of insanity amongst the rapidly decreasing New Zealanders; but here, again, the effects of European vices are evident. The history of the race is one continued warfare, and it may be conceded that in this instance, as in all others of the same kind, this constant pugnacity must hide a good deal of unreason. A chief whose insanity assumed the ordinary type observed amongst warlike savages, and was persevering in his enmity, cautious before the fight, and furious during and immediately after bloodshed, would not be deemed a madman. Doubtless there have been many such heroes in the world's history. These remarks will apply to the native tribes of the American continent and to the comparatively unknown races of Central and Western Asia; but it should be remembered that amongst the more nomadic nations the constant migrations and the frequent absence of a settled home must give any of the mentally afflicted a poor chance of keeping up with their fellows in the struggle for existence. The amount of insanity amongst the Mahommedan nations is probably much greater than is ordinarily believed, and there is no doubt that those religionists who manifest their sanctity by extraordinary physical exertions and tortures contain a large percentage of men who are not much more mad than the founder of the Faithful was.

It is impossible to admit that many of the great conquerors who were the curse of the world were sane. Cambyses, Alexander, and Attila were subject to attacks of homicidal mania, which were only salient points in a long period of unreason qualified by the prevailing warlike spirit. Their insanity took on the type which reflected the ordinary disposition of the age. So did that of Saul and Ajax. It is hard to believe in the sanity of Domitian and Nero, or of many of the emperors whose bloodthirstiness was appalling, and whose cruelties were atrociously wanton, and especially as madness was so common in the best days of Rome that its symptoms have been admirably rendered by the physicians of the period. Violence, homicide, and suicide, although the most marked of the symptoms of the earlier civilizations, were not unaccompanied by the melancholy madness so common at the present time. Hippocrates notices a case of melancholia in a woman of his day, "from an accidental cause of sorrow." She lost her power of sleep, and had aversion to food, and suffered from thirst and nausea, being of a melancholic turn of mind. Her cure by nature is recorded also. The method of madness simulated by David bears witness to the acquaintance of the Philistines of Gath with the complaint. otherwise the stratagem would not have had the desired result. Thus early in the history of the world the sanctity of the insane was clearly acknowledged. The unsatisfactory notices of uncivilized and ancient madness appear to indicate the prevalence of violent maniacal and homicidal attacks, and the opposite condition of imbecility. There is every reason to believe that the affliction does not increase amongst savage nations, and that it never attained a very great importance in classical times. Probably the mass of the demented of Europe was not represented by a corresponding type of disease in the olden time. The truth is melancholy enough now.

The increase of the population of England and Wales and Scotland year by year is beyond doubt; and unfortunately, so far as England is concerned, there is no doubt about the yearly increase of pauperism. Emigration has been compensated for by the annual excess of births over deaths, and it is certain that the exodus has not taken away a great proportion of the best of the peasantry, as it has in the case of Ireland. The condition of the agricultural labourers and miners has slightly improved; but that of the population of the worst parts of our great cities has retrograded.* On the other hand, commercial enterprise and great engineering operations have raised a vast number into the lower middle class; and have excited increased mental activity and its corresponding anxieties. The mercantile world has passed through great ordeals, and wealth has been unusually uncertain during the last few years. There is hardly a small circle of acquaintance that cannot tell of some ruin amongst people who have been prosperous; and the details of the results of the immoral conduct of "financiers" abound with lists of the well-educated who have to put up with the greatest privations, and whose mental sufferings can better be imagined than expressed. According to the popular idea the increase of insanity should have been found amongst the middle and upper classes, and the private asylums should have received an unusual number of patients of late.

---

* At a recent meeting of the Liverpool Select Vestry, a brewer (*sic!*) attributed the fulness of the lunatic asylums which he had visited to indulgence in poisoned beer.

The following Table, taken from the last Report of the Commissioners in Lunacy, is singularly corrective of the popular idea, and confirmative of those opinions which connect insanity rather with defective constitutional vigour and a low state of the nutritive functions than with increased mental strain and anxiety.

INCREASE OF PRIVATE AND PAUPER PATIENTS IN THE ASYLUMS OF ENGLAND FROM 1863-67.

Year.	Total Number of Pauper Patients on 1st January.	Increase during the Year.	Total Number of Private Patients on 1st January.	Increase during the Year.
1862	20,949	..	5250	
1863	21,998	1049	5340	90
1864	22,958	960	5327	− 13
1865	23,763	805	5177	−150
1866	24,995	1232	5277	100
1867	25,998	1003	5286	9
Increase in 5 years		5049	..	36

It will be seen that there is a steady increase of our pauper lunatics, at the rate of about 1000 a year, whilst there are only thirty-six more private patients in asylums than five years ago. The increase of the general population has been great, yet the small number of 36 when placed *en rapport* with its numbers amounts to nothing as regards increase, and infers a decided decrease.

The Table is carried on in the Report up to 1868 and 1869, and the number of pauper lunatics admitted into asylums in those years was 27,363 and 28,728 respectively. But this return does not refer to all the pauper lunatics; for the workhouses contained 7963 lunatics in 1859 and 11,181 in 1869; and there were 5798 insane paupers in 1859 living with their relatives, and 6987 in 1869. Thus the whole pauper lunacy of England and Wales amounted to 31,782 cases in 1859, and to 46,896 in 1869. The population in 1859 amounted to 19,686,701, and in 1869 to

21,869,607. That is to say, with an increase of population of 2,182,906, there were no less than 15,114 pauper lunatics. In the corresponding time, and with the same increase of the general population, there was a gross increase of 840 cases amongst those who came under the notice of the Commissioners as private patients in asylums and at home with their friends and committees.

Doubtless many a lunatic whose friends are above the pauper class is kept at home and escapes the notice of the Commissioners, but any increase in the numbers of the "private" class which might accrue in this manner is compensated for, when the relative numbers of the insane are considered, by the number of pauper lunatics who are aged and simply demented, and who are not under supervision. There appears to be a reasonable foundation, then, that there is a decided increase in the lunacy of the pauper class, and that it is slight among the non-pauper class.

This assertion has been most ably and temperately contradicted by one of the late presidents of the Medico-Psychological Association, and in 1861 by the Commissioners in Lunacy. They then wrote the following sentence, which very properly heads Dr. C. Lochart Robertson's essay on the subject:—"We have not found any reasons supporting the opinion generally entertained that the community are more subject than formerly to attacks of insanity."* In 1869, Dr. L. Robertson wrote, "that the alleged increase of lunacy is a popular fallacy, unsupported by recent statistics." He quotes the words of the President's address, read July 31, 1867:—"During this period (1847–1867) the total number of pauper lunatics and idiots has increased from 17,952 to 42,943. While in 1847 one in every 880 of the whole population was a pauper lunatic, this proportion is now, in 1867, one in 494. I do not attribute these numbers to any actual increase in insanity, but rather to the fact of the more accurate returns which are now made of the pauper lunacy of the country, and also in some degree to a number of persons in the lower middle class successfully contriving to evade the restrictions of the poor law, in order to procure for their insane relatives treatment in the county lunatic asylums. This opinion of the absence of any positive increase in the lunacy of the country is further supported by the relative proportion of private patients to the population in the same period."

Popular fallacies and general impressions are very obnoxious to the dogmatic under any circumstances, and they become exasperating when they receive support from the most recent and official statistics. The following Table from the Commissioners' Report for 1868, published July, 1869, gives support to the "popular fallacy," if figures are of the least value, and unless the Commissioners wish to throw dust in our eyes.

---

* Report, 1861.

Year.	Population.	Total Number of Lunatics, January 1.	Proportion to Population.
1859	19,686,701	36,762	1 to 536
1860	19,902,713	38,058	1 „ 523
1861	20,119,314	39,647	1 „ 507
1862	20,336,467	41,129	1 „ 494
1863	20,554,137	43,118	1 „ 477
1864	20,772,308	44,795	1 „ 464
1865	20,990,946	45,950	1 „ 457
1866	21,210,020	47,648	1 „ 445
1867	21,429,508	49,086	1 „ 437
1868	21,049,377	51,000	1 „ 424
1869	21,869,607	53,177	1 „ 411

The gradual and progressive increase is, according to this Table, most evident; and if the Table of the increase of private and pauper patients in asylums already noticed is examined, the same remarkable support to "popular fallacy" is given. The increase of the number of admissions is evident. Unless there is an increase in the lunacy of the general population, and especially in the pauper class, these statistics must be misguiding and erroneous. It may be asked when did the inaccuracy of the returns culminate, and when did the operations of certain Acts of Parliament particularly influence the singularly and equably progressive percentage noticed above. The operations of the Act of 1843 may have suddenly swollen the returns up to 1859, but it certainly did not do so afterwards. The Act of 1861, writes Dr. L. Robertson, "rendering pauper lunatics chargeable upon the common fund of the Union, instead of on their parish, led to a further increase in the number of lunatics and idiots sent to the county asylums." But, on comparing the proportion of the lunatics to the general population in the years 1862, 1863, and 1864, when this increase of admissions to asylums would have taken place, there is no proof of any great access to the number of known lunatics, and simply because they were all allowed for in the returns of the Commissioners before the passing of the Act.

Since 1862, the statistics of the insane published by the Commissioners have not been subject to any disturbing causes; they are not calculated to mislead in the manner suggested, and we are bound to accept the fact that there is a steady increase in the lunacy of the population of England, Wales, and Ireland, especially amongst the pauper class, and to admit that for once popular fallacy is supported by recent statistics.

The bearing of statistics upon the ultimate causes of insanity is evident. It warrants the plain statement of Dr. Richardson,—"Our uneducated cloddish populations are, in short, as I venture to assume, the breeders of our abstract insanity; while our educated, ambitious, over-straining, untiring mental workers are the breeders and intensifiers of some of the worst forms of physical malady;"* and it is very ably considered by the Commissioners,† who write as follows:—"The population of England may be estimated in round numbers of 20,000,000, of which 1,000,000 are paupers; and we have thus the remarkable fact of an increase in asylum patients in five years of 5049 from the million of paupers, and of only 36 from the 19,000,000 of non-paupers. Making very liberal allowance for the pauperizing effects of lunacy, and the consequent removal of a considerable number of patients from the independent to the pauper class, we are thus forced to the conclusion that insanity *is essentially a disease not of the overstrained intellectual or emotional faculties, but of the depraved bodily condition which for the most part is dependent on insufficient or inappropriate food, irregular living, overcrowded dwellings, long-continued nursing, overwork, fever, or any similar cause of bodily debility.*" They might have added the influence of want of mental exertion, and of hebetude produced by the sameness of the mental surroundings; for a large section of the human race dies more or less insane from prolonged stupidity.

The number of the insane in Ireland should afford a very satisfactory proof that the affliction accompanies, and is more or less produced by causes which relate to the general nutrition and vital force, instead of those which have to do with exaggerated emotions, intense mental work, and hard labour.

The population of Ireland is steadily decreasing, and the agricultural wealth has been on the whole increasing for the last ten years; but the condition of the agricultural class is very much the same as it was fifty years since. The constabulary obtain very exact returns of the numbers of the insane who do, and who do not receive parochial relief; and thus the whole amount of mental alienation may be determined very correctly. The returns made by the asylums, workhouses, and gaols, taken with those of the constabulary, and compared with the decreasing population, show a decided increase in the numbers of the insane from 1851 to 1861, and that although there has been a decrease in the population since 1861, there had not been a corresponding decrease in the numbers of the alienates.

Dr. MacCabe has given some very interesting statistics concerning the county and city of Waterford, which maintain a considerable agricultural and a small urban population. He considers the district to present a fair picture of an average Irish agricultural district, the population of the city of Waterford qualifying a character that might otherwise be described as exclusively agricultural. In 1851 the lunatics of all classes in Ireland numbered 15,098, being in the proportion of 1 in 433 of the population, which was 6,552,385. Ten years later, in 1861, the population numbered 5,764,543; a decrease of 12·20 per cent. The number of the insane thus amounted to 15,947, or 1 in 361 of the population.

---

* 'Journal of Mental Science,' October, 1869.

† Report, 1869.

Dr. MacCabe gives the following statistics of Waterford:—The county and city comprise an area of 721 square miles, or 461,553 acres, of which in round numbers 325,000 are arable, 105,000 uncultivated, 23,000 in plantations, 1500 in towns, and nearly 6000 under water. In 1851, four years after the famine, the population of the district amounted to 164,051. The numbers of the insane were:—In the asylum, 121; in workhouses and gaols, &c., 61; at large, 56: total, 238. Ratio to the population, 1 in 689.

In 1861 the population of the district amounted to 134,336, a decrease in ten years of 29,715. The numbers of the insane in the district were:—In the asylum, 135; in workhouses and gaols, 69; at large, but returned by the constabulary, 182: total insane of the district, 386. Ratio to the population of 1 in 348.

In 1868 the population had evidently declined from the figures given in the census of 1861. The numbers of the insane were:—In the asylums, 167; in workhouses and gaols, 90; at large, 120: total insane of the district, 377. Ratio to the population, 1 in 358. The increase in the numbers admitted into the asylums and workhouses depended upon the operation of Acts of Parliament, but the significance of the sum total is not to be mistaken. There was an evident increase in the numbers of the insane for ten years, and no decrease of any amount since 1861, so far as Waterford was concerned.

The last returns of the insane population of Ireland for 1867 and 1868, December 31st, in both years are, for the first year, 15,650; and for the last, 16,018. In 1861, it has been already mentioned, the insane numbered 15,947. Of course a correct estimate of the relative numbers of the insane and sane cannot be obtained until the census which is about to take place is completed. But, as a matter of fact, it is known that the general population did decrease from 1851 to 1861, and there is a strong presumption from the emigration returns that a steady exodus makes a sad inroad into the ranks of the peasantry year by year. No one credits that there is any increase of the population, and therefore the numbers of the insane must be believed to be on the increase, and to have increased year by year in Ireland in relation to the population.

Esquirol's remark that insanity belongs almost exclusively to civilized races of man, and that it scarcely exists among savages, being very rare in barbarous countries, holds good; and the experience of the last twenty years proves that he might have said with great truth that in the most civilized countries where there is the greatest wealth, industry, and learning, there there is the greatest poverty and misery and the largest amount of insanity.

The success of the treatment of the insane, so pleasurably commented upon by our legislators and by magistrates in sessions, can be estimated by statistics, and the result of a fair inquiry is remarkably unsatisfactory.

Thirty-five years have elapsed since Prichard's celebrated treatise on insanity appeared, and during that time the asylum system and the "moral management" treatment have gradually attained a great development; that is to say, the old miseries of the insane have to a great degree been replaced by conditions which at least are very satisfactory to the public. If insanity were not a curable disease, if it were perfectly beyond the action of remedies, and if it were a special affliction far beyond the influence of material entities, civilization might be congratulated upon having influenced the minds of men in the direction pointed out by the philosophy of Christianity. Fine buildings, many of them admirably adapted for their object; delightful grounds; elegant corridors, hung with pictures and ornamented with flowers, and decorated with taste; a large staff of nurses and attendants; well-educated and benevolent medical men; a perfect system of hygiene, diet, and supervision, and sedulous commissioners and visitors. These are the most prominent accessories of the modern system, and they are most creditable to humanity. But when Hodge's wife leaves him in a snug ward, whose surroundings are quite palatial to her wondering senses, and returns to her dirty hole of a cottage, to satisfy the hunger of half-a-dozen young children upon bread, dripping, and tea, she wants to know whether all this splendour will cure her John safely, quickly, and pleasantly, and what he will think of home when he comes out. The people who sent her John to the asylum know that he will not be cured cheaply, and some have the curious taste to say that if it were not for those confounded lunatics many healthy-minded individuals might have a holiday now and then. As it is, the rates are the devourers of such luxuries. Some restless inquirers have not yet been sufficiently educated up to the proper appreciation of the grandeur of the modern system, of its psychological literature, and of its staff of officials and commissioners. Such Bohemians will ask questions which are considered proofs of gross ignorance by the profession: and some have the assurance to assert that the magnificent accessories of the treatment of insanity have not been of great assistance to humanity. They urge that lunatics are not more frequently cured than they used to be; that the number of recoveries from insanity has not been increased; that the holding down of violent patients and the fracturing of their ribs by keepers is not a bit better or more Christian treatment than placing them in strait-waistcoats and fastening them down with straps; and that the whole asylum system is uselessly expensive and detrimental to the majority of the insane and unphilosophical, especially as no means have been adopted by the State to prevent the occurrence of that misery and pauperdom which develops lunacy.

Many independent thinkers, whilst they admit the sedulous care that is taken of the insane in asylums, and believe that cruel treatment is very exceptional, are by no means satisfied that much progress has been made by medical science in the cure of the alienated. The inmates of asylums are well taken care of, and they are as comfortable as they can be; but with all this there is a doubt whether the cures increase year by year with the experience of the psychological gentlemen. There is even a doubt expressed about the applicability of the asylum system to many cases of chronic insanity, and the Commissioners hint at a want of individual attention to demented patients. Certainly the Commissioners have forced the present system of shutting up all lunatics upon the nation, and have necessitated an enormous expenditure; but it becomes a serious question whether the whole of the insane who are not affected with the disease in its acute form, and who are not dangerous to themselves and others, would not be better off under very different circumstances than those of the model asylums. The heavy expense of the present system is admitted, and the anxiety of the physicians to do their best also. Now let us consider some results.

Prichard, writing thirty-five years since, notices the remarkable results of Dr. Burrows' treatment. He writes:—"Dr. Burrows has reported from his own experience 240 cures in an aggregate of 296 cases of various descriptions; 221 cures from recent cases; 19 cases from 64 old cases; affording a proportion of 81 in 100 of all cases." He acknowledges the general surprise that this high percentage of recoveries has excited, but notices that it coincides nearly with the statements of Dr. Willis. Dr. Jacobi, of Siegburg, in Westphalia (1830), cured 40 in 100 cases, and kept his patients sufficiently long under his eye to render any doubt about their perfect cure impossible. Esquirol collected the results of 5360 cases, and found 2691 recoveries, and this was between A.D. 1798 and 1813. This is at the rate of nearly 50 per cent. In a report made officially in Paris in 1825 of the state of the hospitals for lunatics during the three preceding years, and which was considered by Dr. Burrows, the recoveries were proved to be 34 in 100. Esquirol tabulated the returns from English lunatic hospitals from 1748 to 1814, and found that the percentage of cases was about 33 against the 50 per cent. in France. The cures at Bethlehem Hospital from 1819 to 1833 amounted to rather more than 50 per cent. In the Stafford Asylum, from 1818 to 1828, the cures were about 43 in 100 admissions. In Wakefield County Asylum from 1819 to 1826 the cures were 42 in 100. In Lancaster County Asylum from 1817 to 1832 the cures were about 40 per cent.

The Gloucester Asylum from 1823 to 1832 dismissed nearly 50 per cent. of its inmates cured. The same average result was obtained in the Retreat, near York, from 1812 to 1833.

Now it must be admitted that the treatment of the insane was, so far as comfort and science were concerned, at a very low ebb during the early twenty-five years of this century. The "magnificent period" has lasted from 1835 to the present day. What do the statistics of recoveries (which relate to the past thirty years) prove in comparison with those just mentioned, and which belong to the past? In the Somerset County Asylum 3284 patients were admitted from 1848 to 1868, and the recoveries were 42 per cent. The average number of the cures of the Scottish Asylums amounts to about from 37 to 40 per cent. The average percentage of recoveries to admissions into English asylums during the past ten years has been, for the county and borough asylums, 33·93; and for the private licensed asylums of the metropolis, 27·60. It follows that the cures of the insane in our fine asylums are not more numerous than they were from 1748 to 1814, when the treatment of the insane was a disgrace to humanity. If anything is to be made out of the statistics, the percentage of cures has rather fallen off. Whilst every other disease has been less persistent and has been more curable, insanity remains as a dead-weight on the statistics of our social miseries. To refer this unsatisfactory state of things to the comforts of asylums, or to the system of treatment adopted by the able men who labour in this thankless part of the medical profession, is simply absurd.

The cause of the mass of incurability is tolerably evident, and the defects of the system which prevent a cure are so also.

It is admitted that the majority of the insane are more curable during the first year of the attack than subsequently, and that mania is, as a rule, followed by recovery in from 90 to 95 per cent. of cases. But every month that ela[illegible] without amendment in the mental condition complicates the a[illegible]tion and diminishes the chance of recovery. Every relapse acts in the same manner. The quiet and chronic cases are of course those whose persistence in the same state renders the percentage of causes so unsatisfactory. Not only is the malady produced in them, either by hereditary predisposition, by a long perversion of the nutrition of the brain by reason of mental and moral abuse, or by organic disease, but it is perpetuated by the rest-and-be-thankful treatment which sooner or later must be adopted under the present system. The routine of an asylum and its moral and physical atmosphere act after a while perniciously. The want of definite work, of exercise which interests, of relief from miserable sights, and of those happinesses of home which cannot be replaced by any luxurious comforts, together with the effects of the dismal companionship of fellow-sufferers, during the periods of temporary sanity, are constantly producing depressing results. Dr. Boyd, writing in 1869, states that in his experience the tubercular class of diseases produces very fatal results in the chronically insane. He remarks, that "However we regard the fact, whether from the numbers collected, or from insanity being more prevalent amongst phthisical (consumptive) patients than others, or from both causes, the mortality from tubercular disease was about double amongst chronic cases of insanity in both sexes to that of the adult male and female population of England in 1866." The longer the duration of the residence in the asylum, the greater was the mortality from consumption.*

In ordinary medical practice the consumptive are not more frequently transferred to the alienist physician on account of mental derangement, than those suffering from other diseases, and of course less frequently than those with disease of the nervous system. It is the depressing effect of association and of the want of physical labour that adds to the list of the consumptive in our great asylums.

Here, then, is one of the most prominent causes of the incurability of the insane brought into definite relation with the asylum system. Even if it were admitted, which it cannot be, that the majority of the insane are afflicted with tubercular diseases before they enter asylums, the peculiar arrangements of the establishments are not those which would benefit the constitution or retard the issue.

Consider another point. The miseries and the excitements of one age were pretty well equalled in all others; but it is by no means clear that education, however trivial, does not add to the wretchedness of the pauperized, and of those who, whilst they witness the splendid luxury and waste of their fellow-men, are dragged down by circumstances into a hopeless condition of semi-starvation and drudgery whose only termination is in a long vista of want, with the poorhouse and grave in the distance. The want of mental and physical resiliency amongst the poorest of our urban and agricultural populations is evident to those who care to mix with them. The well-disposed and honest are in constant fear about the sustentation of their families, and the careless are, as a rule, steady drinkers and unsteady workers. The wants of the primitive condition of mankind are superadded to the miseries of our social state; and the poverty, which is hardly ever to be cast off, prevents that healthy direction of the mind and senses which the early hunters enjoyed, but which appears to be incompatible with the present state of things. There is nothing wonderful, then, in the statement that the present condition of the pauperized, and of those who must become paupers in the ordinary course of events, is favourable to hebetude and to mental decadence, as well as to physical degeneration. It is clear that the majority of the pauper insane enter asylums with the malady in their very bones, and year after year hereditary predisposition adds to its intractable nature. Our social state is producing year after year an increasing amount of insanity more than ever difficult of cure.

---

* 'Journal of Mental Science,' 1869, pp. 200–2.

It is evident to those who can consider the question dispassionately that the method of treatment of the majority of the chronic cases forming the bulk of the inmates of asylums is inordinately expensive, unsatisfactory as regards its results, and not right in principle. It is a failure. There is no doubt about the efficiency of the treatment adopted in asylums in cases of mania and in those where suicide is feared; moreover, there is a social necessity for separating those thus afflicted from their fellow-men. The total alteration of scene and diet, the moral influence of strange faces, and of the clock-like regularity of the establishment, constitute, however, with that valuable medicine, time, the principal curative agents. Medicine, so far as drugs are concerned, has advanced very slightly since the time of the Greeks in the treatment of insanity, and no important addition to our knowledge concerning the relation of drugs to insanity has emanated from the alienist physicians of the past twenty years. Every severe disease has attracted the urgent attention of the medical profession, and those which were formerly very fatal are now so managed that a cure is by no means rare, and, moreover, it bears a definite relation to the administration of drugs. But the medical treatment of the insane is in the hands of a few, and the alienists constitute a very close borough: so of course no progress commensurate with the spirit of the age is made. Kind Nature cures the majority of the lunatics who recover, but she certainly does not get the credit. She is opposed by the asylum system in the cure of the chronic cases, and therefore they remain much the same as fifty years since.

Our social errors produce such types of madness that even the Commissioners are downhearted, and begin to be philosophical. They write, despairingly, as follows:—

"Hitherto our efforts have been mainly directed to the provision of asylums for the cure and care of the insane; but these efforts, however beneficial they may be in many respects, have, as we have seen, totally failed to meet the increase of lunacy. That more successful results would be obtained from the rational education of the people, and from the introduction of physiological instruction into schools, may very reasonably be expected. The prevention of insanity is not only a far nobler aim than the provision of accommodation after the mischief has been done, but it is one which there is reason to hope would greatly contribute to sap the sources of pauperism."*

The rational-education cry is all very well, but, for reasons already given, there may be much doubt whether it will be the panacea for lunatic pauperism. Our difficulty is not, however, at present how to prevent insanity, but how to treat the apparently incurable—those who do not receive benefit from the present asylum system—properly and successfully, and without extravagant outlay. When a system is fully developed, any proposition which interferes with it is of course ridiculed. Just as the asylum system was a matter of slow growth, and one full of trouble and mistakes, so all others, more or less antagonistic to it, must commend themselves to us, whilst they pass through stages of incompleteness, misdirection, and error. If the insane colony of Gheel is mentioned as a reasonable institution, its shortcomings are of course placed prominently before us, but really they are equalled in many English asylums, and its statistics prove that the unfortunate patients afflicted with chronic insanity are cured in about the same ratio. They have more liberty, and it is possible for them to wear out their irritability by continuous labour. Certainly they do not cost so much for maintenance as the English demented, who crawl about the yards and grounds of the asylum like flies out of season. But a system of treatment of the chronic insane on the Gheel plan, and without its evident errors, would give the afflicted a better chance than they now have. There are many large asylums with plenty of land around them, and some of the insane work on the land; but this labour is not universal, and its mercantile value is always considered. If a superintendent turned the whole of his chronic cases out into the fields day after day, and managed to direct the attention of each one to work which was possible, it would not be a more troublesome proceeding than teaching a class of idiots (and this is well done, after a while, with perseverance), and the benefit must be great. If a great village, with proper cottages, was founded in each county on land which could be cultivated without any great loss by skilled labour and by the chronic insane, the success would not be less, so far as curation is concerned, than it now is, and it might be greater. The comforts of the patients would be the same, and the same staff of officials would be necessary. The dreary walls, the awful sameness of surroundings, the close company of fellow-lunatics sadly differing in mental peculiarities, would be got rid of, and the restraint would be reduced to its minimum. Doubtless there would be occasional scenes of trouble, excitement, and violence; but are there not such within the walls of the best-regulated asylums? Perhaps they might be less frequent under the open canopy of heaven. As a matter of expense, there can be no doubt that the village system would be very economical, in fact just as reasonably so as the present asylums are scandalously expensive when their expenditure is contrasted with their results.

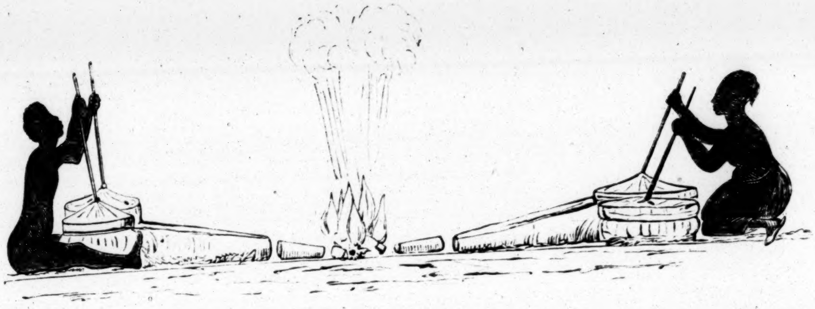
---

* Report, 1869.

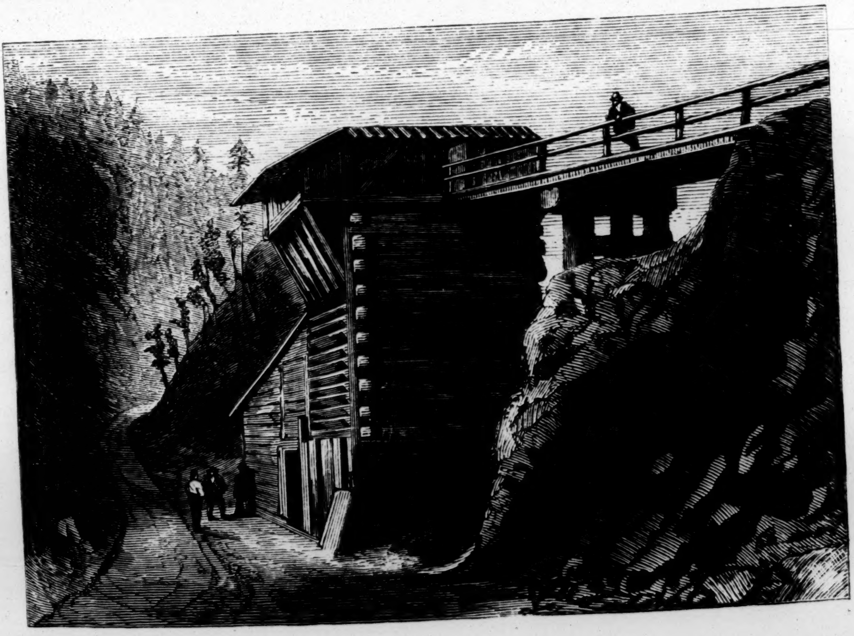
The old notions concerning the origin and nature of insanity are rapidly going out of fashion, and it is ceasing to be considered a disease of the mind *per se*. This change of belief implies no irreverence towards God's special providence, but a growing opinion that many peculiarities of modern civilization are sufficiently antagonistic to the laws of nature to render unstable that normal balance between the mind and the body which almost invariably exists in savage nations. Providing that the body is well nourished and the brain well worked, there appears to be no increase of mental alienation in spite of mercantile disaster and political changes. Let long years of unrequited toil, insufficient and improper nourishment, be passed amongst all that degrades humanity, and the improperly educated brain will become unhinged by an unusual series of exertions. Civilized poverty is the hotbed of insanity and of a type which is singularly irremediable. It follows that whilst moral management may be necessary for some lunatics, a special physical treatment which must bear a definite reference to the constitutional causes of the ailment is absolutely required for the majority. This method of treatment cannot be obtained under the present system of seclusion in asylums where the success in re-establishing reason is not greater than it was when all the horrors of the madhouse were in full force, but it may be successfully carried out under an intelligent supervision, adapted to the village and cottage system foreshadowed by the insane colony of Gheel.

III. THE METALLURGICAL INDUSTRY OF CLEVELAND.

Throughout the whole history of applied science and the metallurgic arts there is probably nothing which can at all compare with the condition of things now prevailing in Cleveland. In the more limited acceptation of the term, Cleveland is, strictly speaking, but a small portion of the North Riding of Yorkshire,—probably about one-third of it; but, from the fact that the staple industry is the same throughout a large part of Teesdale and South Durham as in Cleveland proper, the term has now popularly acquired a more extended signification. Within a very limited area of the district referred to, the last twenty years have seen an industrial development which has no equal, either in ancient or in modern



1.—The First Age of Iron-making.



2.—The Second Age of Iron-making.

times, at home or abroad. It has been extraordinary, in every sense of that term. It is true that in the minds of many persons who have no practical acquaintance with Cleveland, there is always associated with that name the idea of iron-making; but to the million, and even to many well-educated people, it conveys practically no idea whatever, unless it be of the crudest description. It is not highly improbable that some of the examiners for the Civil Service would themselves fail to pass an examination in the physical and political geography of Cleveland; certain it is, however, that some of their best examinees would be "plucked" if examined on the subject. And yet, while such a great amount of ignorance prevails regarding Cleveland, it is already the greatest iron-making district in this country or in the whole world; and while being the greatest, it is practically the youngest seat of the iron-smelter's art in Britain, that is, if it be compared with South Staffordshire, South Wales, and Scotland.

As there must be some special circumstances to which that remarkable pre-eminence is due, it will be the object of this paper to attempt to trace them out and enlarge upon them. It may be premised that an unusual amount of attention was directed to Cleveland in the autumn of last year, both by the iron and steel trades of the country and by the public at large, owing to the fact that the first provincial meeting of a new scientific association, bearing the name of the Iron and Steel Institute, was then held at Middlesbrough, the capital of Cleveland. That organization had only been formally ushered into existence at the preceding midsummer, by the delivery of the inaugural address of the President, the Duke of Devonshire, the great ironmaster of Barrow-in-Furness; and yet at the time of the meeting referred to it included nearly 300 members, many of them being the most extensive and the most scientific ironmasters and steel-makers in the kingdom. Its success was so great, that there was no room for doubting the wisdom of the suggestion which first gave birth to the Iron and Steel Institute. The originator of the idea was Mr. John Jones, F.G.S., the secretary for the North of England Iron Trade, and now likewise the secretary for the new association, the objects of which were, first, to afford a means of communication between members of the iron and steel trades upon all such matters as bear upon the respective manufactures, and are not connected with trade regulations and wages; and, second, to hold periodical meetings for the purpose of discussing practical and scientific subjects relating to the manufacture and working of iron and steel. Owing to the vast amount of interest, both industrial and scientific, associated with Cleveland, it was highly proper that the first provincial meeting of the Institute should be held at Middlesbrough. It brought together many persons to whom Cleveland was practically a *terra incognita*, and every facility was freely offered to them for the exploration of the district, so that they might have an opportunity of studying those features which had given to the district a history which, though brief, is perhaps the most eventful and interesting in the whole annals of the iron manufacture.

That history may be said, in a measure, to have commenced in the year 1829, when the site of modern Middlesbrough was chosen as a coal-exporting place, owing to its closer proximity to the sea than the town of Stockton, which was then the eastern terminus of the famous Stockton and Darlington Railway, by means of which the South Durham coal-field was connected with the river Tees. Since then the district of Cleveland and its capital, Middlesbrough, have had a most extraordinary career, and have acquired a wonderful importance, whether regarded from a social, industrial, or scientific point of view. About the time just mentioned the site of Middlesbrough had only one solitary farmhouse, while at the present time the municipal borough and its immediate belongings contain a population of about 50,000 inhabitants.

While the first stage of Middlesbrough history commenced in 1829, as already mentioned, the connection of the town with the great national industry of iron-making only began in the year 1840–41, when a rolling-mill and other works were erected for the manufacture of malleable iron on a small scale by Mr. Bolckow and the late Mr. John Vaughan. The former is a German, a native of Mecklenburg, and the latter was a man of indomitable perseverance and unflinching industry, whose practical acquaintance with iron-making had been gained while he was a workman at the world-famous ironworks of Dowlais, South Wales. At the time just mentioned, and for some four or five years longer, Messrs. Bolckow and Vaughan brought their pig-iron from a distance and transformed it into bars, rails, castings, &c.; but in the year 1845 or 1846 they erected several small blast furnaces at Witton Park, near Bishop Auckland, where they expected to secure a suitable supply of ironstone to keep their furnaces employed. The supply soon failed, and then they resorted to what was then known as Whitby ironstone, which they obtained on the Yorkshire coast, at Skinningrove, some ten or twelve miles from Whitby. For a time they continued to work this Skinningrove ironstone, and carry it by ship and by rail, and at considerable expense, all the way to Witton Park to be smelted.

The third period of the history of Middlesbrough and Cleveland began about the end of the year 1850, when the town of Middlesbrough had a population of not more than 7000 inhabitants. It began with the discovery of the same deposit of ironstone almost as far inland from Skinningrove as Skinningrove is distant from Whitby, and quite within sight of Middlesbrough.

The difficulties of shipment were so great, owing to the exposed nature of the coast, that it was deemed very desirable to make a careful examination of the geological structure of the Cleveland Hills. It was in the year just mentioned that the search for the mineral proved successful, and the discovery has been the most eventful circumstance in the history of Cleveland. From the circumstance that the mineral was discovered there, it has since been known by the name of the Cleveland ironstone. Claims have been urged on the part of various persons as the discoverers of this famous mineral, as it has already, within the short period of twenty years, been largely concerned in effecting a great revolution in iron metallurgy. It is not desirable to make any effort in this place to settle those claims; and, indeed, as the Whitby and Cleveland ironstone are one and the same mineral deposit, and as the mineral was certainly known in the year 1822, when it was spoken of in Young and Bird's 'Yorkshire Coast,' and more fully described by Phillips in his 'Geology of Yorkshire,' published in 1835, it would practically be impossible to decide who was *the* discoverer of the mineral. Referring to this subject in his paper "On the Cleveland Ironstone," read before the South Wales Institute of Engineers, in August, 1869, Mr. Thomas Allison says, "Whoever was the first discoverer, the German Ocean may, we think, with justice, be said to have been the first miner, by undermining and denuding the Lias cliffs of the Yorkshire coast, containing the main bed of ironstone, strewing the sea-beach with large blocks of the ore, which, like lobsters boiled, changed their colour to red by billowy and atmospheric influence, while the shaly part of the denuded cliffs was, by the same causes, pulverized and washed away."

The ironstone thus mined on the sea-coast was shipped in large quantities to the ironworks on the Tyne and Wear for a number of years before it was discovered inland. It is even stated that some of it was sent to the Tyne as far back as the year 1811. This, however, is certain, that John Vaughan was the first man to recognize the great industrial value of the inland deposits of Cleveland ironstone, and that to his practical knowledge is due not only the tentative introduction of the ironstone in 1850–51, but the present enormous development of the Cleveland iron trade, based, as it is, on the utilization of those immense deposits of ore.

After the employment by Mr. Vaughan of portions of the ironstone deposit of the Cleveland Hills, its enormous extent began to dawn upon the minds of geologists and mining engineers; and since then its distribution, position, and extent have been most carefully determined by Messrs. Marley, Bewick, Cockburn, Allison, and others. It is stating the facts in a very prosaic way to say that the Cleveland ironstone is deposited in such an enormous quantity as to be practically inexhaustible, and that the mining operations are now conducted upon a most gigantic scale. A few details bearing on these points may not be out of place at this stage.

The ironstone of Cleveland is an impure carbonate, but it does not belong to the Carboniferous series of strata, as do the blackbands and the argillaceous or clayband ironstones. It occurs in some nine or ten seams, distributed chiefly through the Middle Lias group of the Oölitic series; but they are not all worked, nor, from a commercial point of view, are they all workable. The chief source of the ironstone which is at present being worked is the Main Cleveland Seam, the thickness of which is sometimes from 17½ to 20 feet, as at the Eston mines. At other mines it varies from this extraordinary thickness down to 15, 11, and even to 7 feet. At the Eston mines the ore is worked at a depth of nearly 600 feet from the top of the shaft, which opens out on a bleak and uninhabited Yorkshire moor. Sometimes the main seam is split up into two seams by shale and other beds, the upper being distinguished palæontologically as the *pecten* seam, and the lower as the *avicular* seam. Where the main seam is undivided it is generally richer in metallic iron than where it is split into two seams: in the former case the ore may yield from 30 to 31 per cent. of metal, while in the latter the yield is frequently from 28 to 26 per cent. of metallic iron. Cleveland ironstone is highly fossiliferous—indeed, it may be said to be quite charged with animal remains, and consequently there always occurs in the iron extracted from it a notable quantity of phosphorus, the presence of which has hitherto rendered the production of steel from it, without puddling, a scientific impossibility. Analyses of Cleveland pig-iron give not unfrequently from 1·2 to 1·3 per cent. of this troublesome element; and yet, although it is generally regarded as an undesirable ingredient of manufactured iron, it would almost seem that Cleveland iron, in the form of railway bars, has a greater degree of durability than iron which is practically free from phosphorus. Besides the seam referred to—the Main Cleveland Seam—there is another workable seam, known as the Top Bed. Geologically, it is from 230 to 250 feet higher up, resting on the top of the Upper Lias, the chief feature of which is the well-known Whitby alum shale. This Top Bed is only worked at three places—Glaisdale, Rosedale, and Port Mulgrave, on the coast. At Rosedale there is also a peculiarly deposited bed of rich magnetic ironstone, occupying the same geological position as the Top Bed just spoken of. It sometimes yields as much as 49 per cent. of metallic iron.

In a number of places throughout Cleveland the ironstone deposit has been completely removed by denudation. The total extent of the denuded area is about sixty square miles, but even after making allowance for that fact there is an iron-bearing area of about 420 square miles. In one portion of that area the deposit amounts to about 27,000 tons per acre; and in another, where the ore may be said to be of second-class quality, the yield is almost 18,000 tons per acre. The total amount of ironstone obtainable from the Cleveland Hills is, therefore, upwards of 4,500,000,000 tons, an amount so great that one can scarcely form an adequate conception of it. According to the calculations of Mr. William Cockburn, mining engineer at Messrs. Pease's Upleatham mines, the total yielding power of the mines throughout the Cleveland district is now upwards of 5,000,000 tons per annum; and according to the same gentleman's calculations the mineral of the first quality may be expected to last seventy-three years, while that which he considers to be of the second class is almost inexhaustible. It is to be hoped, but hardly to be expected, that the South Durham coal-field will hold out long enough to supply the heating power to calcine and smelt the ironstone which Nature has so bountifully deposited in the Cleveland Hills.

At first the Cleveland ironstone was generally quarried where it cropped out on the surface, but the plan now adopted is to sink shafts from the surface or drive levels from the hill-side, or both, and then work the mineral upon the "bord and pillar" principle. Some of the iron-smelting firms have mines of their own, others contract for their supply of mineral. As the mining operations of Cleveland are conducted upon such a gigantic scale, it is but natural to expect that no antiquated measures are adopted unless their utility has been fully demonstrated. To be "time-honoured" is not alone sufficient; they must be the most economical methods of procedure, both as regards the mineral to be worked and the labour and life spent upon it. One finds in use the most highly approved mechanical appliances, both for "winning" the mineral and for draining and ventilating the mines. As a single illustration it may be mentioned that in one of the mines explored by the present writer —one belonging to Messrs. Bolckow, Vaughan, and Co. (Limited), at Eston—the engine-plane was brilliantly illuminated throughout nearly a mile and a half with coal gas. The same plane is a level or drift which serves as an air-course inwards and a water-course outwards. The water is drained from the mine at the rate of about 600 gallons per minute, and is carried by gravitation to the company's blast furnaces, where it takes the place of water which formerly cost 1000*l.* per annum.

The ironstone, which is the raw material forming the prime requisite of the great industry of Cleveland, is obtained so cheaply that it can be laid down at the furnaces at a cost of 4*s.* to 4*s.* 6*d.* per ton; and as it contains very frequently from 28 to 31 per cent. of metallic iron, the ore for a ton of pig-iron costs less than 14*s.* It is in a very great measure owing to the extraordinary abundance and cheapness of the raw ironstone that the Cleveland ironmasters have, in a comparatively short term of years, acquired for their district the proud distinction of being the greatest seat of the iron manufacture in the whole world.

It was in the month of September, 1850, that the first sample of Cleveland ironstone from the Eston Hill was smelted at the Witton Park Iron Works; but it was only a few months afterwards that active measures were taken for the practical treatment of the mineral at Middlesbrough, within easy reach of the ironstone deposit. Messrs. Bolckow and Vaughan were the first firm of ironmasters to enter upon the Cleveland industry. They were the first to erect blast furnaces on Tees-side, and were really the original pioneers of the present gigantic trade of the district. But there were other firms who soon cast in their lot with Messrs. Bolckow and Vaughan by erecting blast furnaces in the district. Chief among these, it is but proper that mention should be made of Messrs. Bell Brothers, of Clarence Iron Works, Messrs. Gilkes and Wilson, Messrs. Cochrane, and Mr. B. Samuelson, M.P. They were keenly alive to the great resources of the district, and they brought great practical and scientific abilities and commercial energy to bear upon those resources. Their example has since been followed in a most remarkable manner, and the energy which has since been displayed has been most wonderful, if not even unique, if one may judge by comparing the state of things now prevailing with that which existed twenty, fifteen, or even ten years ago—for even within the last five years or so, the ironworks of Middlesbrough and its immediate vicinity have been nearly doubled in number.

As already indicated, the chief or primary circumstance to which this extraordinary scientifico-industrial development is traceable is the almost inexhaustible store of comparatively rich ironstone lying quite at hand in the Cleveland Hills; but there are other circumstances which must also be taken into consideration. A sojourner in the district can scarcely fail to be struck with the wonders that surround him on all hands. To a few of the circumstances which strike a stranger to Cleveland—but who is not a stranger to the iron trade—reference may now be made.

I. *Calcining Kilns.*—In the Cleveland district the ironstone is in some instances calcined before leaving the mines, but in most cases it is calcined in very close proximity to the blast furnaces where it is to be smelted. The operation is effected in calcining kilns, never in open heaps or "bings," such as may be seen in various iron districts. These kilns have no very distant resemblance to lime-kilns. They are generally of very considerable size, sometimes fifty feet in height, and upwards of twenty in width; indeed, they are frequently a good deal larger than many of the blast furnaces of South Staffordshire, South Wales, and Lanarkshire. The raw ironstone is raised to the top of the stacks of calcining kilns, either by inclined planes up which the laden waggons are dragged, or by hoists of great ingenuity. As a rule, it is thoroughly roasted or calcined by means of one ton of small coal or "breeze" to from thirty to forty tons of green ironstone. In every direction labour-saving appliances are to be found. Even in the discharging of the kilns an ingenious hopper arrangement has been applied, which economizes labour to a remarkable extent. The roasted stone is charged into great iron barrows without any shovelling being required, and by means of them it is lifted in the furnace-hoists to the top of the furnace, and charged into them quite hot. This plan of charging the furnaces with calcined ore while it is dry and quite hot also effects some economy in the fuel.

II. *The Blast Furnaces: their Number, Size, and Mode of Working.*—The blast furnaces of Cleveland form quite an extraordinary feature throughout the whole district, whether we regard their number or their size, or the mode of working them. In no other iron-making district can such a sight be seen as that which meets the eye of the visitor to Middlesbrough and the district immediately surrounding it. At the present time (February, 1870) there are no fewer than 122 blast furnaces in the Cleveland district, if under that term it may be permitted to include Durham, considering that Cleveland ironstone is almost universally used in the blast furnaces of that county. True, there are twelve of that number of furnaces that are not likely ever to be again brought into use in their present form, as they are too antiquated, and not in accordance with the prevailing notions as to what a blast furnace should be. Then there are other nine which are out of use, but as they are available they may again be called into requisition. There are thus left 101 furnaces, all of which are in blast; but besides these there are fourteen new ones being built, one being raised, and other two being rebuilt or modernized. Somewhere about seventy, or about two-thirds of the whole, are clustered within an area so limited that a radius of three or four miles from the centre of Middlesbrough would include almost every one of them.

And then, such furnaces as they are in point of size, almost universally! Throughout Monmouthshire and South Wales there are probably not fewer than 200 blast furnaces, while out of that great number only four or five reach to a greater height than 50 feet. Many of them are only 35 or 40 feet high, and there is even one that rises no higher than 25 feet. In South Staffordshire from 45 to 50 feet is the commonest height for the blast furnaces, and in Scotland the greater of those two elevations is but seldom exceeded. But what a mighty difference is observable throughout Cleveland. Such a puny thing as a furnace only 45 feet high is exceedingly rare, and in comparison with many of the other colossal structures it might almost be spoken of simply as a crucible or a tiny smelting-pot. Heights of from 70 to 95 feet are common throughout the whole district, while at Ferryhill there is one furnace that towers up to the extraordinary height of 103 feet, and is therefore, doubtless, the most gigantic iron-smelting furnace in the world. In the short space of twenty years Cleveland blast-furnace practice has passed through several phases. At first the furnaces were built only 45 feet high, then the height was increased to 56 feet, next to 60 feet, and then (in 1863) to 75 feet, and soon afterwards still greater heights were adopted. Some of them had but very short lives comparatively; they were erected and in use but a few years when it was resolved to raze them to the ground, and rebuild them of much larger dimensions. Amongst the new furnaces now in course of erection it is stated that there are two which are to be built to the height of 90 feet; and even the great furnace at Ferryhill is to be overtopped by one which is to reach a height of 120 feet! And as is the height of the Cleveland furnaces so is their internal diameter at the widest part, or what is technically known as the "boshes." It generally varies from 16 to 25 feet, but in the case of the Ferryhill furnace it is 27 feet. The two 90-feet furnaces just referred to are to be 30 feet wide at the boshes, or one-third of the height; and it is proposed to make the 120-feet furnace no less than 33 feet wide at the boshes. Were the Vulcans and Tubal Cains of antiquity to revisit the earth, they would doubtless stare on coming within sight of these immense smelting crucibles.

When compared with such primitive furnaces as are still in use in Central Africa, as represented in the first of our sketches illustrating "the ages of iron-making" (see Plate I.), the contrast is remarkable in the extreme. It is even still remarkable when such a blast furnace as is in use at Mariedam, in Sweden (Plate II.), is compared with one of the modern or Cleveland type, as illustrated in Plate III.

The internal capacity of some of the Cleveland furnaces amounts to 25,000 or 26,000 cubic feet—that of the Ferryhill furnace being 33,000 feet; and the weekly production of pig-iron from a number of the furnaces—fourteen castings, or two daily—is from 420 to 450 tons; at Norton it is as much as 550 tons. A single casting from one of the Ormesby furnaces has been known to weigh 45 tons. With furnaces which, together with their great number, have such a prodigious yielding power, it is scarcely to be wondered at that the Cleveland ironmasters are now making nearly one-third of all the pig-iron produced in Great Britain. One of them is the greatest individual maker of pig-iron in the world, namely, Mr. Thomas Vaughan, of Clay Lane and South Bank Iron Works. His annual make is nearly a quarter-million tons.

For a considerable length of time a vigorous and interesting discussion has been going on amongst the Cleveland ironmasters with reference to the maximum dimensions that may be allowed in the blast furnaces consistent with a due regard to the highest degree of scientific economy in the working of the same. Mr. Isaac Lowthian Bell, who may perhaps be justly regarded as the greatest authority in the science and practice of iron-making amongst practical ironmasters, has taken his stand after having instituted probably the most elaborate series of experiments in blast-furnace practice ever made. The paper which he read at the Middlesbrough meeting of the Iron and Steel Institute, "On the Development of Heat and its Appropriation in Blast Furnaces of different Dimensions," treats the subject very exhaustively. Mr. Bell obtained his data for calculation from furnaces of almost all capacities, ranging between 3500 and 33,000 cubic feet, and his verdict was that the most economical furnaces would ultimately prove to be those having capacities ranging from 12,000 to 25,000 or 26,000 cubic feet. There are, however, many ironmasters and blast-furnace managers who do not agree with the dictum pronounced by Mr. Bell, and there is a great deal to be said in favour of the assumption that the maximum limits have not yet been reached. In the opinion of Mr. C. W. Siemens, F.R.S., great results must be looked for rather by increase in the temperature of the blast than by simply increasing the capacity or height of the furnace. As a rule, every increase hitherto made in the heights of blast furnaces has been attended with a saving of fuel, not in Cleveland only but in other iron districts also. For instance, by raising the height of some of the cold-blast furnaces at the Lilleshall Iron Works, Shropshire, from 50 to 70 feet, there was a saving of seven or eight cwt. of coal per ton of iron made.

The Cleveland furnaces present a remarkably strange appearance to one who has been much accustomed to the iron-smelting furnaces of the older iron districts. Elsewhere, as in many parts of the "Black Country," Wales, and Ayrshire and Lanarkshire, the furnaces are almost all provided with open tops from which great tongues of flame are constantly belching forth, together with enormous volumes of smoke, indicating prodigal waste of fuel; in Cleveland, however, all the furnaces are close-topped, and the gases generated in the interior are collected and utilized. In the Cleveland iron-smelter's vocabulary the term "waste gases" is unknown. According to Mr. Bell,[*] the system now in operation in Cleveland effects a saving of something like 600,000 tons of coal per annum in those works smelting the ironstone of North Yorkshire. Such scientific economy cannot fail to have important social and political considerations. The mode of closing the furnaces is generally the same in principle throughout the whole district: it is the well-known hopper-and-cone arrangement; and the gases are drawn off very near the top of the furnace, and conducted away by means of capacious tubes to be used in generating steam and in heating the air of the blast. Theoretically, there should be no coal used in either of these operations; they should both be accomplished by means of the furnace gases, and in practice this state of perfection is fully reached at some of the works.* As coke is the fuel used in Cleveland, the combustible gas which is generated consists almost entirely of carbonic oxide, and it is the calorific power of this gas which the iron-smelter has to utilize. Of course, there is also the atmospheric nitrogen of the air of the blast passing through the furnace. Of necessity, it absorbs a vast amount of heat, but of this heat it is well deprived before it is thrown back into the atmosphere.

---

[*] Paper read before the Chemical Society of London. 'Journal of the Chemical Society,' June, 1869.

Since the hopper-and-cone arrangement of closing the furnace-top was generally adopted throughout Cleveland, it has been very materially improved, especially by Mr. Charles Cochrane, of the Ormesby Iron Works, Middlesbrough, a gentleman who is now one of the most active spirits in suggesting and applying improvements in blast-furnace practice. Within the last few years he has contributed no fewer than five papers on various phases of blast-furnace economy to the 'Proceedings of the Institution of Mechanical Engineers,' and all of them have been marked by indefatigable perseverance and by great practical and scientific attainments. His improved arrangement is that of the double-closed furnace-top, and has for its object the diminution of the amount of gas escaping from the furnace at the time of charging. It has done this so effectually that for one furnace the saving in fuel alone is equal to about 164*l.* per annum, while the necessary apparatus only costs 200*l.*

In the hands of the Cleveland ironmasters the great invention which was given to the world by James Beaumont Neilson, namely, the hot-blast, has of late almost revolutionized even Cleveland iron-smelting. Neilson seemed to think that he had arrived at the acme of perfection when he got the temperature of the blast raised to about 600° Fahrenheit; and in Scotland, where the invention had its birth, the blast is rarely heated much beyond that temperature. But in Cleveland, where no such deference is paid to old customs and traditions as they receive in Scotland and in South Staffordshire, there seems to be no resting-place. Improvement succeeds improvement with extraordinary rapidity, and at present it is in the direction of increased temperature in the blast rather than in increase of furnace capacity that further economy is to be sought for. It is no uncommon thing in Cleveland to find the blast heated to from 850° to 1000° Fahrenheit, but even the greater of those temperatures is not deemed sufficient. Under the leadership of Mr. Cochrane the tendency is still upwards. That gentleman has applied at the Ormesby Works the Siemens' regenerative system as adapted by Mr. E. A. Cowper, C.E., F.R.S., for the heating of the air of the blast. He has of late used the blast at the unprecedented temperature of 1452° Fahrenheit, and the result of his experience is that for each 100° that the blast is raised there is a saving of 1·34 cwt. of coke per ton of iron made. It is the opinion of Mr. Bell that 21 cwt. of coke per ton of pig-iron is about the lowest minimum that can be attained, but Mr. Cochrane is sanguine that a minimum of 13 cwt. can be reached, provided that the blast is heated up to 2000°, and he has determined to aim at reaching that minimum consumption of coke unless experience should prove it to be impossible to attain it. Even a consumption of only 21 cwt. of coke per ton of pig-iron must be deemed very marvellous, when it is remembered that twice that amount is employed in producing a ton of iron in cold-blast furnaces. There are instances of furnaces in the Cleveland district—Consett and Ferryhill—working on a consumption of 17 or 18 cwt. of coke per ton of pig-iron, but they are somewhat exceptional, as the ironstone used was either the rich Rosedale stone or not exclusively Cleveland stone, but a mixture of it with hæmatite, and therefore containing at first a much larger proportion of metallic iron than is customary throughout the district. Superheated air is also in use at Consett Iron Works, the temperature of the blast being about 1400° Fahrenheit, and produced in a hot-blast stove, which is a modification and simplification of the Siemens-Cowper stove in use at the Ormesby Works. Report speaks of it very favourably as a fuel-saving appliance. The inventor of it is Mr. Thomas Whitwell, of the Thornaby Iron Works, Stockton.

---

* At Mr. Samuelson's Newport furnaces no coal whatever has been used for several months.

Various other appliances and improvements have been brought to bear by the Cleveland ironmasters upon the great industry in which they are engaged. By the use of separate heaters, water is generally fed into the boilers in a boiling condition or nearly so. Furnace materials have to be lifted to such vast heights that hoists of almost every conceivable variety have been devised and brought into use;—the water-balance hoist, the vacuum hoist, the air-pressure hoist, and the water-column hoist, may all be mentioned as exhibiting special meritorious features of engineering construction.

From the facts already alluded to, and on account of the interesting scientific and practical problems which are at present being worked out, the eyes of all iron-making districts are anxiously directed to Cleveland. It is iron-smelting which really forms the staple industry of that district, and although it is scarcely twenty years since it had its very small beginning, it is already of such enormous proportions that every other district is completely overshadowed by it. But although iron-smelting is *the* staple industry of Cleveland, it is not the only one. The manufacture of malleable iron is carried on to an immense extent throughout the district with great skill and energy, and it has called into requisition some 1400 or 1500 puddling furnaces, possibly even more: and some of those furnaces are amongst the most economically effective appliances known to the metallurgist. In some of these the consumption of coal per ton of puddled bar has been reduced from 25 to 15 cwt. It was in Cleveland, likewise, that works were first erected by Messrs. B. Samuelson and Co. for the practical application of the Siemens-Martin process of manufacturing steel; and the experiments made by that firm at the Newport Works would seem to indicate that there is a great degree of probability that steel ingots for rails may yet be made at a price little exceeding that of puddled bar. This is not the place to enlarge upon the fact, but it may be stated that in the Cleveland iron trade two great social problems have been solved, namely,—1. The prevention of strikes and lock-outs, by the establishment of the Board of Arbitration and Conciliation; and, 2. The possibility of the co-operative system being carried out in a large iron-making establishment,—the employés participating with the capitalists in the division of the net profits of the business. This system has been in operation during three years at the works of Messrs. Fox, Head, and Co., and it has just been resolved to continue the arrangement for the next five years.

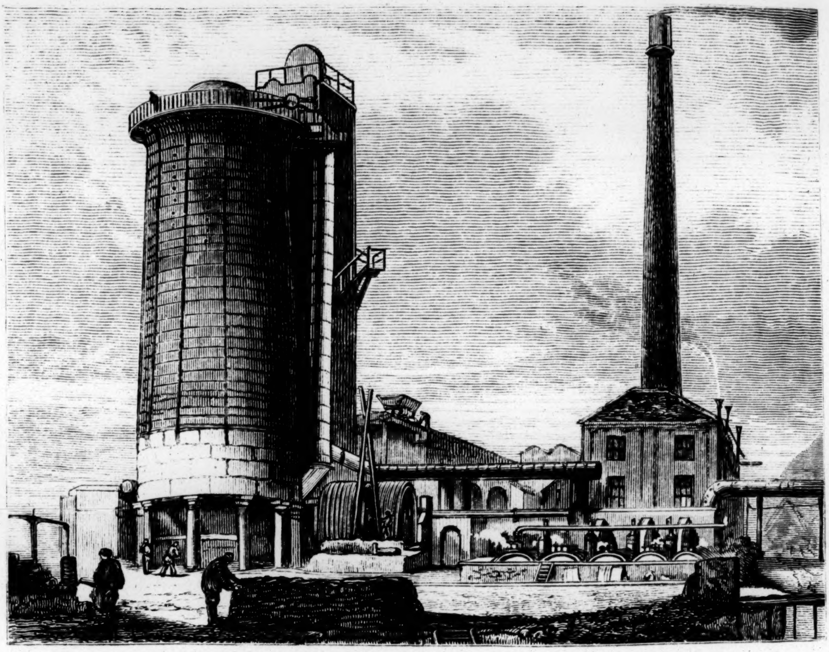
Great scientific and industrial results have been accomplished by Cleveland already, but it is not too much to expect that she has in store other equally great, if not even greater, triumphs for the historian to record.

The production of rails in Cleveland is at the present time not far short of 750,000 tons, and probably three-fourths of all the iron-plates used in shipbuilding are made from Cleveland iron.

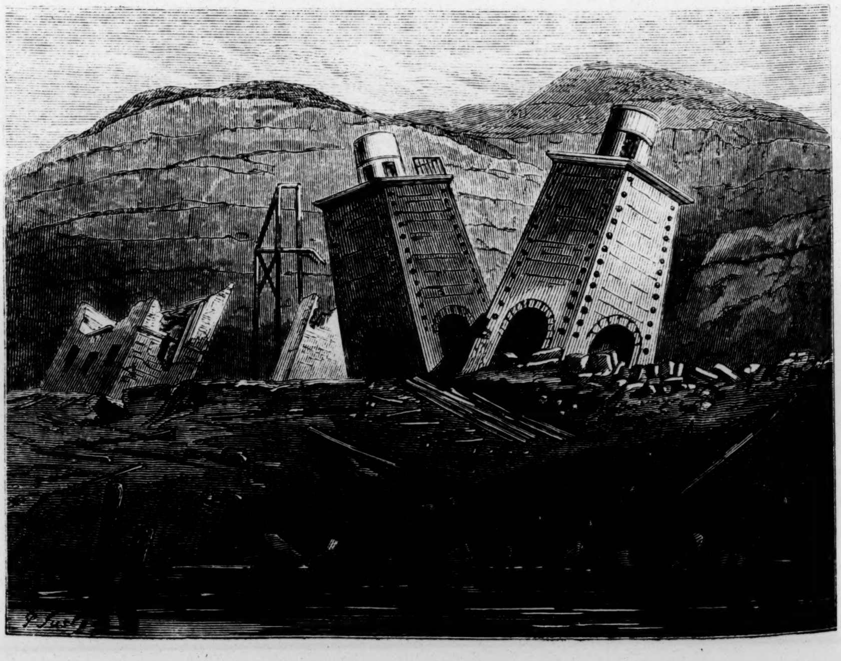
The readers of this Journal will recollect that brine-springs have been found under the town of Middlesbrough; and there is every likelihood of the manufacture of salt being added before long to the other industries of Cleveland.

Publications and authorities referred to in the foregoing article:—

1. *Proceedings of the South Wales Institute of Engineers.* Vol. VI., No. 5. August, 1869.
2. *Proceedings of the Cleveland Institution of Engineers.* November, 1869.
3. *Iron and Coal Trades' Review.* (Article—"The Industrial Features of Cleveland.") 15th September, 1869.



3.—Third, or Cleveland Age of Iron-making.



4.—Death of an Ironworks.

4. *Transactions of the Cleveland Literary and Philosophical Society—Science Section.* Vol. I., 1868–69.
5. "On Our Foreign Competitors in the Iron Trade:" A Paper read to the North of England Ironmasters, by I. Lowthian Bell. 29th September, 1868.
6. "The Chemistry of the Blast Furnace:" A Lecture delivered to the Chemical Society of London, by I. Lowthian Bell. 1869.
7. *Transactions of the Iron and Steel Institute.* Session 1869.
8. *The Industries of the Tyne, Wear, and Tees.* 2nd edition. Longmans.

DESCRIPTION OF THE XYLOGRAPHIC PLATES.*

I.—FIRST AGE OF IRON-MAKING.—A pen-and-ink sketch, made by Captain Grant, who accompanied Speke to Lake Nyanza. It represents native Africans making malleable iron direct from the ore. The ore is placed in the low charcoal fire, and a man on each side urges it by means of bellows (two single-acting—that is, four single-acting in all), so as to keep up a continuous blast.

II.—SECOND AGE OF IRON-MAKING.—Illustrated by the blast furnace at Mariedam, in Sweden, where the low hearth has passed through the intermediate stage of the *blanofen*, and arrived at the high or true blast furnace for the manufacture of pig-iron. Height, about 40 feet; built of rough stones bound together by logs of timber painted red; using charcoal, and making from thirty to forty tons per week during four or five months in the year.

III.—THIRD OR CLEVELAND AGE OF IRON-MAKING.—Illustrated by the Wear Furnace at Washington, co. Durham. This furnace makes about 330 to 350 tons of iron per week from coke made on the spot, the heat from the coke ovens being used for heating the blast. The furnace gases are also partially used for this purpose, for raising steam for the blast engine, and for boiling down certain solutions in the adjoining chemical works. The exhaust steam from the engines heats up a large quantity of water required in the chemical works. The ore smelted is the Cleveland stone, with a small quantity of residual oxide of iron from the chemical works, nothing being wasted.

IV.—DEATH OF AN IRONWORKS.—This sketch represents two furnaces, built on a landslip, on the Yorkshire coast. After the works were finished, the land slipped a little further, and reduced the place to a ruin within two months. The owners, nothing daunted, rebuilt the works, and a second ruin resulted from the total absence of ordinary judgment shown in building on such a site.

---

* The photographs for these plates have been kindly contributed by I. Lowthian Bell, Esq.

IV. ON "TROPHIC NERVES."

By GEORGE ROLLESTON, M.D., F.R.S., Linacre Professor of Anatomy and Physiology, Oxford.

ALL physiologists, and indeed all observers, whether physiologists or not, are agreed that the nervous system intervenes most powerfully, and that not rarely, in controlling and modifying the processes of what we call "organic life." Growth and development, it is true, may be carried on, food may be assimilated, and secretions may be elaborated, independently of nerves and nerve-centres in many lower animals; but, on the other hand, it is equally true that in more highly organized creatures there are but few processes of vegetable life which may not be, at times and to a greater or less degree, brought under the influence of their cerebro-spinal systems. As to the facts, there is no question; as to the way in which the facts are brought about, however, there is a very wide difference of opinion. This difference is expressed in the contradictory answers given by representatives of various biological schools to such questions as:—Can the nerves act directly upon cells other than muscular fibre cells? Can nerve-force interfere with the cell territory otherwise than by regulating the stream of nutriment brought within the borders of that territory by the blood-vessels? Are there, finally, "trophic" and secretory as well as vasomotor nerves? The indirect action of nerves upon tissues in the way of vasomotor regulation of the blood-vessels supplying them is more readily comprehensible by us, but that nerves can act directly upon cells pigmentary, secretory, and other cells, as well as upon contractile cells and fibres, appears to the present writer all but equally demonstrable. Change of colour in ourselves is usually dependent upon vasomotor change; but change of colour in the frog has been most conclusively shown by Professor Lister to be dependent upon molecular movements carried on in the interior of cells under the influence of the nervous, and under circumstances which exclude the intervention of the blood-vascular system. A force which can be seen to produce molecular movement within a pigment cell, may well be supposed to be competent to produce nutritional or chemical changes in the interior of cells of other characters. But if our knowledge of the convertibility of force makes us ready to allow that nerve-force may show itself by modifying nutrition or by producing secretion as well as by producing motion, our knowledge of the convertibility of function which nerves possess accordingly as they are distributed in one or in another class of tissues makes us slow to accept as a necessity the establishment of a division of "trophic" nerves. Messrs. G. H. Lewes, Philippeaux, and Vulpian have shown that nerves are sensory or motor accordingly as they are distributed to sensory or contractile tissue-elements, and not by virtue of any inherent differences in their own structure; and if we have thus to modify our views, if not as to the use of the words sensory and motor nerves, at all events as to the meanings we attach to them, it would be doubly inexpedient to introduce now new words, "trophic" and secretory; considering, firstly, that they are not old and familiar to us, nor possessed therefore of a claim upon our toleration; and, secondly, that they labour under just the same disadvantage of needing to be used with a mental qualification as the older words in question. This is, however, but a question of words; and it may be well now first to state the facts so far as they appear to have been ascertained by observation and experiment; and then, in the second place, to suggest, or leave the reader to excogitate for himself, such a reading of them as may seem best fitted to bind them together into a bundle easy to be manipulated by the mental hand.

I will begin by giving a few facts which bear directly enough upon the influence exercised by psychical changes and cerebral affections upon processes of vegetative life, but which do not give any clear indication as to the way, whether vasomotor or intracellular, in which that influence is brought directly to bear. Facts of what some persons would call great generality, but what others would, and with greater propriety, call great complexity, are presented to us in the familiar histories of defeated armies and of other bodies of men subjected to depressing psychical influences. Such aggregations of men are found to be more liable to succumb to various unhealthy influences, such as those of dysentery, scorbutus, and malaria, than are other aggregations of men similarly constituted except as to their mental impressions or depression. But *in generalibus latet error;* and as we have exact quantitative observations, showing that prisoners in civil gaols perform the ordinary functions of life less perfectly, and at greater cost to their own organism, as also to that of the body politic, than do honest, or, to use the safer term suggested to me by a warder in Portland prison, *unconvicted* men, we had better refer to them. These observations will be found recorded in the Report of the British Association Meeting held in Manchester in the year 1861, at p. 59, and, *passim*, in a "Report on the Action of Prison Diet and Discipline on the Bodily Functions of Prisoners," which we owe to Dr. Edward Smith, F.R.S., and Mr. W. R. Milner. The "cerebral exhaustion," again, so common in these days of stress and tension, is well known (as well it may be, considering what abundant opportunities we have for observing it) to exercise a similarly "atrophic" influence. Modern language, indeed, by altering the meaning of the word *indolence* from that of *freedom from pain* to that of *freedom from labour*, appears to show us that the real relation of *overwork* to *disease* has been more or less obscurely recognized by the laity, even at times when the faculty inverted the relations of effect and cause which really do exist between many manifestations of mal-nutrition, such as dyspepsia and cystitis, on the one side, and cerebral overwork and spinal exhaustion on the other. It is to Dr. Gull* that we owe a demonstration of the facts that the painful affections specified, as well as others only alluded to, are antecedents, but in the sense in which a man's shadow antecedes him when the sun is at his back; that the doctrine of reflex paraplegia was wrongly applied to those cases; and that they are really to be explained as being of the same character as those furnished to us in the histories of men subjected, in prison, as if in an experiment, to the working of mental depression.

Simpler cases still are furnished to us by the well-authenticated accounts of persons losing all their hair after cerebral injury.† When we consider how large an organ the brain is relatively to the rest of the body, and how, protected as it is by its lodgment within an air-tight cavity, it can say to all other organs of the body, "Thou shalt want before I shall," there is no need to waste time in imagining how its derangement may and must entail derangement throughout the entire body. It may be profitable to discover by investigation how this secondary derangement is brought about, whether indirectly by vasomotor alteration, or directly by molecular disturbance set up intracellularly. At present the necessary investigations have not been set on foot; and, *ad interim*, we may colligate the facts under Mr. Darwin's expression of "correlation of growth."

We come in the third place to cases of greater simplicity still; and by this we do appear at first sight to be brought within the sphere of the explanation which the phrase "Trophic nerves" implies. These cases are constituted by the accidental severances of nerves which take place in civil, and more especially in military life, the musculo-spiral nerve, whence the greater part of the thumb and lesser proportions of the three fingers next to it receive their dorsal supply, being specially well fitted for such experimentation, and specially obnoxious to it in the "pious pastime" of war. Dr. S. Weir Mitchell has put on record, in 'The Contributions relating to the Causation and Prevention of Disease, and to Camp Diseases,' edited by Dr. Austin Flint, and published by the United States' Sanitary Commission, some very valuable observations as to the effects of such injuries to nerves. These we find summed up as follows by a writer in the 'Edinburgh Monthly Medical Journal' for January, 1869, at pp. 646, 647:—

"There is a careful and interesting description of glossy skin following wounds of nerve-trunks. The appearance of the skin in this condition has been likened by Mr. Paget to that of chilblains. The integument becomes red and polished, in spots or patches. The hair is wanting. Sometimes the sensibility remains as usual; sometimes it is increased; sometimes diminished. The case cited as exceptional is curious enough. A man received a bullet wound, apparently implicating the axillary artery and musculo-spiral and median nerves. 'Very early in the case his first and second finger and thumb slowly enlarged without any premonitory signs, and with slight darting pains.' This continued after the wound had closed. Two months after the wound the skin of the affected part peeled off *en masse.* Seven months after the injury, when the case was last seen, sensation was wanting in the first, second, and half of the ring finger, and in the half of the thumb, though neuralgic pains were referred to these parts. The palm and first two fingers were enlarged. The skin was thickened, and of a dark purple colour. It is not surprising that the American surgeons should be struck by the resemblance between this and the disease called Elephantiasis Arabum. While in India, we have several times seen two or three fingers enlarged to twice the size of the others, and the skin pink and glossy, contrasting with the black skin of the rest of the hand.

---

* See 'Guy's Hospital Reports,' iii., 7: 1861.

† See 'Lancet,' July 10, 1869; and 'Holmes' System of Surgery,' i., article "Accidents from Lightning," p. 750.

"Other lesions of nutrition or secretion following wounds of nerves are also pointed out. Sometimes there were copious acid sweats; sometimes there was dryness or desquamation of the skin, vesicular eruptions, or incurving of the nails, or subacute inflammation of the joints, favouring the conclusion that the lesion of the nervous trunks acts upon the nutrition of the parts, independently of the loss of sensation or motor power."

The nutritional lesion at the peripheral distribution of the nerve, however, may, if it persist sufficiently long, become in its turn the causative condition of what was in the first instance but a result in common with itself of the lesion of the nerve-trunk. For Dr. Mitchell "claims the merit of having pointed out what was practically unknown before his own researches, namely, that loss of motor power, in a vast majority of cases, is finally due less to neural defects than to those obstinate consequences in the range of nutrition which result from the loss of nerve-power, and which may continue long after the motor power has been partially or completely restored."

Many similar cases may be found recorded by Mr. Jonathan Hutchinson in a very valuable paper, consisting of "Observations on the Results which follow the Section of Nerve-trunks, as observed in Surgical Practice," which was published in the 'London Hospital Reports' for 1866. Mr. Hutchinson is inclined to explain the phenomena of lessened temperature and those of lessened power of maintaining temperature which accompany these lesions, by the lessened *vis a fronte* of the tissues surrounding the capillaries and acting then upon the circulation. The present writer is only half inclined to believe that this is a *vera causa* in animal hydraulics or "hæmaulics;" and that at all events we are not absolutely necessitated to accept it as such, though the absence of any other plausible hypothesis may be seen from the following record of an observation made and published by him before he was acquainted with either of the two memoirs just referred to. This record will be found in 'Medicine in Modern Times,' at p. 69, and to the following effect:—

"The following short history seems to me to be a good instance of the action, or rather of the want of action, of the peripheral nerve-system upon the arterioles. A man, who came some years ago under my own care had had a bullet pass through his arm just above the elbow, so as to sever the musculo-spiral nerve. The scars of exit and entrance were in the lower third of the arm. Under ordinary circumstances the soft parts of the lower arm maintained their natural consistence; but their power of resisting changes of temperature was greatly impaired, as well of course as the sensibility of the parts supplied by the injured nerve. I recollect seeing the swollen state of the inner side of the hand one cold, raw morning, when the man was on sentry duty, and had his hand chilled down by the musket he had to carry. Now, I apprehend that this turgescence is to be explained by saying that the local or peripheral nerve-system of the affected parts was competent under ordinary circumstances to regulate the calibre of the arteries; but that its activity was liable to be depressed, as under the circumstances related, into actual abeyance in the absence of any possibility of any assistance being supplied to it from the cerebro-spinal nerve-axis. Thus, under the depressing effect of cold, which seems to work here much as it does in checking the regeneration of artificially amputated parts in snails and in salamanders,* the peripherally-placed ganglionic system was put into abeyance, and turgescence of the vessels it ordinarily supplied with 'tone' ensued."

It may be said that we do actually know and can see that a nerve when severed from its central connections undergoes fatty degeneration; that it is reasonable to suppose that its mal-nutrition may entail a consentaneous mal-nutrition in the parts which it supplies; and that this secondary mal-nutrition may account for the reduction thus witnessed of the tissues of warm-blooded animals to the level of those of the cold-blooded classes. But to this we reply that atrophy of the nerve-trunk is one thing, and a thing very demonstrable; whilst atrophy of the terminal nucleate plexus, in which so many nerves have of late been shown to terminate, is another thing, and as yet an undemonstrated one. Indeed the physiological existence of these peripheral nervous apparatus has only just established itself as a fact in science,* and so far as the writer is aware, nothing has as yet been attempted as to their pathological history. And weighing hypothesis against hypothesis, the writer still thinks his own, which would explain the facts in question as referable to an impairment of power, to be, at least for the earlier stages of the history, as probable as the counter-hypothesis, which suggests a consentaneous though early alteration of nutrition, as an explanation of the phenomena.

---

* 'Müller's Physiology,' by Baly, 2nd edition, i., p. 444; Bonnet, 'Œuvres,' tom. v., i., pp. 328, 329.

It may be well to add that the changes in question, or at least some of them, have been observed in non-traumatic cases of nervous disease, such as shingles affecting the arm.†

The cases which we shall now, in the fourth place, proceed to relate appear to us to show distinctly that nerve-force can act on tissues, and that directly, without, that is to say, any intervention of the blood-vascular system. The first of these is a typically good instance recorded by a typically good observer. In the twentieth volume of the 'Medico-Chirurgical Transactions' (1837) we find the late Sir B. C. Brodie writing as follows:—"A man was admitted into St. George's Hospital in whom there was a forcible separation of the fifth and sixth cervical vertebræ, attended with an effusion of blood within the theca vertebralis, and laceration of the lower part of the cervical portion of the spinal cord. Respiration was performed by the diaphragm only—of course in a very imperfect manner. The patient died at the end of twenty-two hours; for some time previously to his death he breathed at long intervals, the pulse being weak and the countenance livid. At length there were not more than five or six respirations in a minute. Nevertheless, when the ball of a thermometer was placed between the scrotum and the thigh, the quicksilver rose to 111° of Fahrenheit's scale. Immediately after death the temperature was examined in the same manner and found to be still the same."

Now temperature often rises in the presence of great lividity, in the absence, that is, of any but a very imperfect degree of arterialization or oxidation, though not, of course, in the absence of chemical change. Dr. Gray, of this place, informs me, as I write, that in a case of pneumonia, recently under his care, the temperature rose as high as 106° F. But in the case just quoted from Sir B. C. Brodie's memoir no such over-active cell-formation as that which characterizes pneumonia, and indicates its presence by monopolizing the currency of chlorides, can be reasonably supposed to have been present; and we appear to be shut up to the accepting as an explanation the showering down from the irritated and isolated segments of the spinal cord of such an amount of stimulus as was competent to throw the tissues of the lower parts of the body into active chemical change. That this explanation is a *vera causa* the following facts will show. Dr. Semper, in his magnificent work on the Philippine Archipelago,* has given us an account of certain Echinodermata, of the class Holothurioidea, the source of the article of commerce known as "trepang," from which we learn that several of these curious animals have the power of dissolving their integument into a kind of amorphous slime, upon irritation even of so gentle a kind as simple removal from the sea water. In the case of one species, *Stichopus naso*, it has been found necessary to kill them by heating the water without removing them from it, as otherwise their dense integument runs into dissolution, and the animal is spoilt for the Chinese market, in which, when well preserved, it commands a specially high price. If, now, fragments of the integument of one of these creatures be placed under the microscope, and whilst there, be irritated with the point of a needle, the process of self-dissolution is observed to be expedited in direct correspondence with the amount of stimulus applied. In this diffluent slimy mass beautiful reticular and nucleate nerve-plexuses are to be seen, surviving, which is not always the lot of destructives, the destruction they have brought about. Nothing can speak more clearly to the "catalytic" power of nervous organs, unless it be the rationale given by Mr. Paget, as reported in the British Medical Journal for January 22, 1870, of the formation of sloughs and bed-sores. There Mr. Paget is reported to have observed that "simple *loss* of nerve-power is followed only by *wasting* of the paralyzed parts; but if in addition to loss there is *disturbance* of nerve-force, we then find disturbances of nutrition quickly following the injury, such as extensive bed-sores and sloughing of integument on the feet." To this we should add that if the nerve-system does not play the part of King Stork, other irritants may; and that animal structures deprived of the eminently animal assistance which a connection with a central nervous system secures to them succumb to shocks to which, when thus reduced almost to the level of vegetable tissues, they ought not in fairness to have been exposed. The discordant results of observations as to the consequences of paralysis of many, and especially of the trifacial nerves, can be harmonized if these two considerations are kept before the mind.

---

* See Stricker's 'Handbuch der Lehre von den Geweben,' ii., p. 189, 1869. Dr. Beale, 'Royal Society's Proceedings,' 1865, p. 249.

† See Paget, 'Medical Times and Gazette,' 1864, March 26, *cit.* Handfield Jones. 'St. George's Hospital Reports,' vol. iii., 1868, p. 99.

For the literature of this subject and much else that is valuable relating to it, see *Handfield Jones*, '*St. George's Hospital Reports*,' iii., 1868, p. 89; *Funke*, '*Lehrbuch der Physiologie*,' Bd. ii., 62 to 775; 1866: *Herman*, '*Grundriss der Physiologie*,' pp. 79, 293, 298; 1867: *Dr. Anstie, in* '*The Practitioner*,' *March*, 1870, p. 166. 1868.

---

* 'Reisen im Archipel der Philippinen,' iii., 72; iv., 158, 171; v., 200.

V. RECENT OBSERVATIONS ON UNDERGROUND TEMPERATURE, OR THE CAUSES OF VARIATION IN DIFFERENT LOCALITIES. By EDWARD HULL, M.A., F.R.S., Director of the Geological Survey of Ireland.

WITHIN the last year several series of experiments on the rate of increase of underground temperature of more than ordinary interest have been carried out, on which I propose to offer a few observations. On a former occasion I ventured to give a summary of the experiments which had at that time been carried out on this interesting branch of inquiry, and to point out a course which, in my opinion, would if adopted enable us to ascertain the rate of increase at depths hitherto unexplored.* It is satisfactory to find that the plan proposed has met with the approval of the Committee appointed by the British Association for the Advancement of Science, for the purpose of "investigating the rate of increase of underground temperature downwards in various localities." The report for the past year, drawn up by Professor Everett at the request of his colleagues, has now been issued, and contains an account of experiments undertaken by Sir William Thomson, F.R.S., and his assistant, Mr. McFarlane, in the vicinity of Glasgow, and by Mr. G. J. Symons at Kentish Town in the metropolis, at the deep boring of the New River Company. These observations were taken in water which filled the bore-holes, each layer or stratum of water being assumed to correspond in temperature with that of the surrounding stratum of rock; and the instruments used were those invented by Sir W. Thomson and Professor Phillips respectively for avoiding a source of error (though one not of much importance) arising from the pressure of the water at considerable depths on the bulb of the thermometer.

Of the two experiments made near Glasgow: one, taken at Blythswood reached a depth of 525 feet, with an ultimate temperature of 59·52°;† and the other, taken at South Balgray, reached a depth of 347 feet, with a temperature of 53·69°. At a depth of about 60 feet the constant temperature was reached, and the result obtained at the Blythswood bore was 1° for every 50·5 feet, and at the South Balgray bore 1° for every 41 feet, a rate of increase much in excess of the former; and, I may add, of the mean results of other experiments.‡

---

* 'Quart. Journal of Science,' vol. v. 1868.

† All measurements of temperature in this paper are given in degrees of Fahrenheit.

‡ The rapid increase in this case appears to have arisen from the large proportion of shale at the depth between 390 and 450 feet. Mr. W. Hopkins has shown that the increase of temperature is in the inverse ratio of the thermal conductivity. 'Phil. Trans.,' vol. cxlvii.

A question of speculative interest was determined in a bore made at Kirkland Neuk. A coal-seam passed through had been charred, owing to contact with greenstone (or trap rock); and the question occurred, "Are there any remains of the heat which charred the coal in ancient times; or has it passed off so long ago that the strata are now not sensibly warmer on account of it?" The observations seemed to establish the latter alternative, the bore being colder than its neighbour—that taken at Blythswood.

The observations taken at Kentish Town extended to a depth of 1100 feet, with an ultimate temperature of 70°, giving the mean rate of increase at ·0191° per foot, or 1° per 52·4 feet, the mean surface temperature being taken at 49°.

In the case of the Kentish Town bore-hole, notwithstanding the care taken to prevent the influence of the external air affecting the temperature of the water in the well, it was found by Mr. Symons that this influence extended to a depth of nearly 200 feet,—the temperature of the water rising and falling with that of the season of the year down to this depth. The well, however, was no less than 8 feet in diameter.

The experiments undertaken at Rose Bridge Colliery, near Wigan, by the manager, Mr. Bryham, which I have recently communicated to the Royal Society,* deserve special notice, as having been made during the sinking of the deepest coal-pit in Britain. The results arrived at differ so strikingly from those obtained at Dukinfield Colliery, situated near the eastern border of the same coal-field of Lancashire, and only a little less deep, that a discussion of the cause of this discrepancy may not be without interest.

An account of the observations at Dukinfield Colliery, undertaken by Mr. W. Fairbairn, F.R.S. (1848–59), has already been given in the pages of this Journal,† and was originally communicated by Mr. W. Hopkins to the Royal Society.‡ The depth of the shaft is 2151 feet, with an ultimate temperature of 75·5° taken in the seam of coal known as the "Black Mine" of that district. The mean result is a rate of increase of 1° for about every 83·9 feet.

The observations at Rose Bridge, near Wigan (1854–61), were at first extended only to the depth of 1800 feet, giving a resulting temperature in the strata of 80°; but it having been determined by the proprietor to carry down the shafts to the "Arley Mine" coal, which was known to be at a depth of over 600 feet below, operations were commenced in the spring of the year 1868, and in the space of fourteen months the Arley Mine was successfully "won." The total depth reached was 2424 feet, with an ultimate temperature (taken in the coal itself) of 93·5°. Throughout the whole series of experiments from 1650 feet downwards, the increase appears to have been tolerably uniform, giving the impression that there were no disturbing causes at work. The resulting proportionate increase was found to be 1° for every 54·57 feet; the "invariable stratum" being assumed at 50° of temperature, and at a depth of 50 feet from the surface. The results of the observations at Rose Bridge as compared with those at Dukinfield show a remarkable dissimilarity. The rate of increase in the former case being much more rapid than in the latter: for assuming the same standard of departure in both cases, it will be found that in the case of Rose Bridge the rate of increase is 1° for about 47·2 feet as against 1° for about 83·2 feet at Dukinfield; an amount of discordance which I am satisfied is to be explained on other grounds than those of error in the observations themselves.

---

* 'Proceedings of the Royal Society,' vol. xviii. (No. 116), p. 173.

† Vol. v., p. 17. ‡ 'Philosophical Transactions,' vol. cxlvii.

Such a diversity of results cannot be attributed to differences in the conducting powers of the rocks in each locality: for although sections of moderate depth taken at two different parts of the same coal-field would undoubtedly present different proportions of the sandstones, clays, and shales, &c., arranged in a varying manner to one another, which combine to form what is termed the "Coal-measures;" yet if observations in each case be extended downwards to considerable depths, such as those in the present instance which exceed 2000 feet, the varieties of strata will tend to balance each other, and all cause of discrepancy in the rate of increase of temperature will probably disappear, or be reduced to such a degree as to be immaterial.

Neither is this diversity to be attributed to the presence or flow of water in the strata; for, as I observed on a former occasion,* the percolation of water decreases with the depth, and at variable distances from the surface altogether ceases; or is limited to the very small quantity which appears in some cases to have been locked up in the strata for ages, and which of course takes the temperature of the surrounding strata themselves. We must, therefore, seek for other causes to explain the dissimilarity of results in question.

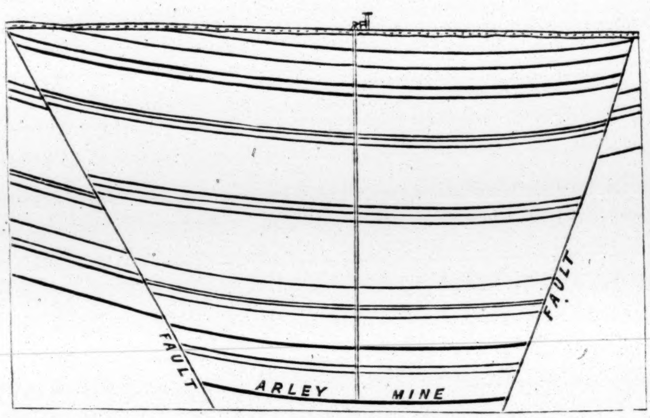
The amount of inclination in the strata, is a cause of variation in the rate of increase which has not as yet been sufficiently taken into account, but is one which I think ought not to be lost sight of, especially in comparing results obtained at moderate depths. In the case of strata of uniform composition throughout, as the Chalk, or New Red Sandstone formations, the amount of inclination is of comparatively little importance; but where we have to deal with a formation such as the Coal-measures, composed of variable strata alternating with each other, and possessing varying degrees of thermal conductivity, the inclination, or amount of dip of the beds, becomes an element of much importance when the rate of increase of temperature is under discussion. In my communication to the Royal Society I have ventured to suggest that the discordant results obtained at Rose Bridge and Dukinfield are to be attributed to the difference in the inclination of the strata at the two collieries, and I propose to enter a little more fully into the discussion of the question here. I shall now describe in detail the position of the strata in each locality.

---

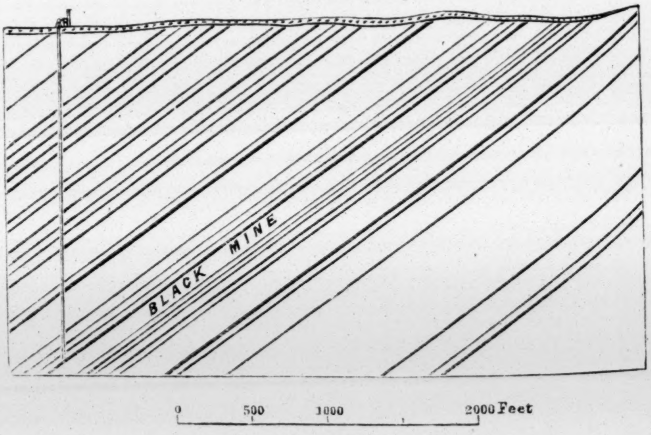
* "Experiments for Ascertaining the Temperature of the Earth's Crust." 'Quart. Journal of Science,' vol. v., p. 18.

Sections showing relative positions of the strata at Rose Bridge and Dukinfield Collieries.

Rose Bridge Colliery.



Dukinfield Colliery.



Scale of Feet.

Rose Bridge Colliery.—That part of the South Lancashire Coal-field known as "the Wigan Coal district," is traversed by a series of parallel faults, ranging in a north-westerly direction, with occasionally very large displacements of the strata. These faults divide the coal-field into sections or "belts;" and where the strata are let down between two faults, a "deep belt" is produced; on the other hand, where the strata are thrust up, "a shallow belt" is the result. The same coal-seam being thereby placed at a less depth from the surface than in the case of the "deep belt."

Between these faults the strata incline at small angles, generally dipping gently to the eastward.

Nearly in the centre of one of these "deep belts," Rose Bridge Colliery is situated; the belt being bounded on the west by the "Standish fault," along which the strata are let down on the eastern side about 150 yards; and on the east, by the Kirkless Hall fault, along which the strata are let down on the west about 600 yards. At the colliery itself the strata are almost horizontal; consequently all the strata, except those comparatively shallow, are broken off by the large faults above described before they reach the surface.

Dukinfield Colliery.—The circumstances of the strata at this colliery are very different from those of Rose Bridge. The pits are situated on the Cheshire side of the river Tame, near Ashton-under-Lyne, and in this district the beds rise and crop out to the eastward at high angles. At the colliery, the dip is west at about 35°, and the "Black Mine" (or coal), which was reached at a depth of 2151 feet, crops out at a distance to the eastward of little more than 1000 yards.

From this account it will be seen that we have very different stratigraphical conditions in each locality, and to this I attribute in a great measure the difference in the rate of increase of underground temperature in these localities respectively. For purposes of comparison we may assume a constant supply of heat from the interior of the earth, tending to travel towards the surface. In its progress it meets with strata of different conducting powers, the thermal conductivity of each stratum in the same locality being in the inverse ratio of the rate of increase, as shown by Mr. W. Hopkins, F.R.S.,* in other words, where the rate of increase is rapid the conducting power is small.

But whatever may be the conducting power of a series of strata, it seems probable that it is impeded when the heat has to travel in a direction perpendicular to the planes of bedding. On the other hand if the heat can find its way towards the surface partly along the planes of bedding, the thermal conductivity is increased, and the rate of increase is proportionally lessened; for in this way it may be conveyed by strata which have high conducting powers, and escape along the outcrop of the strata themselves.

If this view be correct, we can at once account for the difference in the results at Rose Bridge and Dukinfield collieries. In the former, owing to the horizontality of the strata, the heat can only find its way outwards directly across the planes of bedding. We may, therefore, suppose that the resistance to its motion is increased thereby; the conductivity is lessened, and, in consequence, the rate of increase of temperature is rapid. In the case of Dukinfield it is inferred that, owing to the high inclination of the strata, some of the heat travels along the planes of bedding, and escapes along the outcrop with greater rapidity than it would if it were obliged to travel solely across the strata themselves.

---

* 'Philosophical Transactions,' vol. cxlvii.

It has been suggested that in the case of Dukinfield Colliery the escape of the underground heat may have been facilitated by the formation of vapour at certain depths, the vapour making its escape along the planes of bedding by the aid of the fissures and porosity of some of the rocks. It is questionable, however, whether the elastic force of the vapour would be sufficient, at the comparatively low temperature of the strata, to overcome the enormous pressure to which it would be subjected at depths much below the surface.

VI. MR. BRUCE'S MINES REGULATION BILL.

MODERN legislation in this country in reference to industrial employments tends more and more to impose on the Government the duty of caring for the health and safety, and at least the elementary education, of those who, owing either to weakness or to ignorance, are unable to care for themselves.

In our Factory Enactments, foreign countries have followed gradually in our footsteps; in the regulations affecting the mining population, on the other hand, we shall probably never attain the completeness of supervision, be it for good or for evil, which prevails in States such as France, Belgium, and Prussia, where the minerals are the property of the nation.

Mr. Bruce's Bill for the Regulation and Inspection of Mines, a *réchauffé* of his Bill of last Session, consolidates the existing laws; but is in other respects as modest a measure as the opponents of Government interference could desire.

It continues to forbid females to work in mines, and, at the urgent request of the operatives, limits, though not to the full extent of their desires, the time during which youths from twelve to sixteen years of age may be employed below ground. Recognizing the failure, in the case of young children working in mines, of the attempt made to combine work and elementary instruction, it forbids entirely their employment underground before the age of *twelve*. It places women, young persons, and children employed on the surface under the provisions, as regards the hours of labour and education, of 'The Workshops Regulation Act of 1867,' which, however, owing to its administration being in the hands of local bodies, is a dead letter. Otherwise than under this Act, it makes no provision whatever for the education of the mining population.

Should Mr. Forster's Education Bill become law in its present form, which leaves each district to judge whether parents shall or shall not be compelled to send their children to school, then the children in the mining districts of the North and of Cornwall will probably learn the elements of reading, writing, and arithmetic. We wish we could expect as much with regard to Staffordshire. The Revised Code must, however, be re-revised before even the former will, as a matter of course, have the opportunity of learning something of the laws of nature on which their safety depends.

As to the persons responsible for the conduct of such hazardous works, to require of them the rudiments not of a scientific but of the most ordinary literary instruction would, according to Mr. Bruce (perhaps rightly for some few years to come, and in certain localities), disqualify unfairly, and without benefit to the community, men who may be competent, though illiterate. We hope that the example set by those West countrymen, who, in addition to their hard day's labour underground, attend the science classes of the Miners' Association of Cornwall and Devon with assiduity and success may, after a time, be followed elsewhere.

The duty of "producing an amount of ventilation in collieries, adequate to dilute and render harmless noxious gases to such an extent that the working-places and roads shall be in a fit state for working and passing," is enforced more peremptorily under the bill than according to the existing law, inasmuch as the proof of its fulfilment is, in the event of an accident, to rest with the owner, instead of being taken for granted unless disproved. Strangely enough both the masters and the miners object to this condition as too stringent. Another provision which renders owners and agents, like the men, liable to imprisonment for breach of rules is more likely to pass, although the objection has been raised that it might lead to the incarceration of the Secretary for the Colonies. Why he should not be imprisoned, if he were to entrust the management of his mines to incompetent managers, does not appear very clearly. We suspect that the locking up of Monsieur Flachat, the Chief Engineer of the Chemin de l'Ouest, after a great railway accident in France, has contributed in no slight degree to the safety of railway passengers in that country.

No change is to be made in the system of colliery inspection, for two reasons: It is supposed, first, that to inspect every mine carefully and at short intervals would require 200 competent officials. This is an evident exaggeration, and one which it is scarcely to be expected that the present body of inspectors will take much trouble to dissipate. At any rate, when it appears that the number of mines of South Staffordshire and Worcestershire

(Mr. Baker's district) is returned at 550, and on comparing it with the returns of the Keeper of Mining Records, we find that more than *two hundred* of that number have ceased working (many of them for six or seven years and longer), this aspect of the question would appear to require further investigation.

The second objection, if valid, would be more formidable. It is argued that the responsibility of the actual managers of collieries would be diminished if a more close and systematic supervision by government inspectors were attempted. Doubtless it would be a mistake to exonerate an incompetent manager on the certificate of an equally incompetent government official. This is not what is wanted, but that the inspectors should have such a knowledge of the condition, as to discipline and safety, of every mine in their district as a personal inspection can alone afford. Where this is honestly attempted, as in Mr. Brough's (the South-western) district (and we mention Mr. Brough's case as an example and not as a solitary instance), the solicitation and advice of a man of large experience and of sound acquirements would tend to bring the practice of inferior managers up to the best standard of their own and other localities.

We are not so sanguine as to suppose that any degree or quality of inspection will prevent a recurrence of lamentable catastrophes. With the increase in depth of our coal mines the frequency of the sudden and dangerous outbursts of gas necessarily increases; against them no management of details is of much avail without the faculty of increasing the supply of air almost indefinitely, now happily afforded by the exhausting fans of Lemielle, Guibal, and others, which are rapidly coming into use in the North of England and in South Wales. Another source of constant danger is the recklessness of the mining population, which will only be removed by such a change in their habits as time and education can alone produce.

But with all this a more vigilant supervision by the representatives of the central authority cannot fail to increase the good order and safety of collieries as it has done that of factories. It appears to us that the country cannot rest satisfied with the present pseudo-inspection, or rather post-mortem revision, serving, as it does in nearly every instance, to show merely that the inspector had no knowledge whatever of the condition in any respects of the pit in which the fatal accident arose.

VII. ON PRACTICAL SCIENTIFIC INSTRUCTION.

By George Gore, F.R.S.

The remarks in the following paper are directed more particularly to education in physical and chemical science, not because there are no other sciences to which they would apply, but because those are the sciences selected as illustrations of scientific education.

It is generally considered that of late years a more rapid progress has been made in trades and manufactures in America and in some of the countries of Europe, more particularly in Prussia, than in this country, and that this is chiefly due, not only to the existence of compulsory elementary education in some of those countries, but also largely to the more general diffusion of scientific knowledge amongst foreign workmen and directors of workmen. So far has this opinion spread amongst those who are best informed upon the subject, especially since the Paris Exhibition of 1867, that it is thought unless great efforts are made in this country to ensure a general and wide-spread knowledge of science, the prosperity of our manufactures must speedily decline.

To avert such a calamity "technical education" has been proposed, and much has been said as to the means of supplying it. "Technical education," in the fuller sense of the words, consists of two things, *viz.* education in a school and instruction in a manufactory; but in the narrower sense it means the practical knowledge and experience acquired during apprenticeship in a workshop.

The object of "technical education" is essentially practical—it is to make each pupil, whether intending to be a master or a workman, better able to fulfil the duties of the special occupation in which he is to be engaged; for instance, to make a worker in brass a better brass-worker; an iron-smelter a more skilful smelter; an electroplater a better plater; a farmer a better farmer, &c.; and the means proposed for doing this is by a suitable course of scientific and technical culture at an early age. Ordinary school education is supposed by some persons to be only intended to impart such a general discipline of the mind as will fit a man for every employment, without fitting him specially for anything. Technical education, on the other hand, is more for the purpose of fitting a man for a special pursuit.

Some persons say technical skill is a quality which cannot be imparted,—it is a gift of Nature. There is no man so great a genius that education will not improve him; skill in art does not come wholly of itself, any more than knowledge of science does. Under the present system multitudes of workmen of ordinary capacity in this country fail to learn because they have no proper teaching; we must not, therefore, trust to genius only, and the "rule of thumb," as we have hitherto done, but judiciously impart scientific instruction to minds of ordinary capacity as well as to others.

The education necessary for a workman cannot be completely supplied either in a school alone or in a workshop alone. The duties and pursuits of a school are incompatible with those of a manufactory, and it is not possible that a workshop should also be a school of science. In an ordinary school, boys should be taught the general scientific facts and principles upon which trades and manufactures are based; and in the manufactory they should learn the practical directions for working in their trades, and acquire experience in manipulation.

It is manifest that no scientific education, whether technical or otherwise, can be imparted except upon the basis of a sufficiently good elementary secular education; and as long as the elementary education in this country remains in its present extremely imperfect state, it is impossible for this nation adequately to advance in scientific knowledge, or keep pace with the progress of foreign intellect.

It may be asked,—At what point is the school education to stop and the workshop education to begin? This admits of a sufficient although not a precise answer: in a general way school education would cease where manufacturing manipulations commence, but this would vary with the kind of school. The relations of science to trade would be carried to a farther stage of development in a "trade school" than in a school of a different kind; and in courses of lessons or lectures on technology, than in ordinary scientific instruction; they would also usually receive further development in schools in a manufacturing district than in those of other places. In a usual way the technical portion of ordinary school education would include illustrations of the principles and facts of science by descriptions of manufacturing processes, by models and diagrams of apparatus used in manufactures, and by specimens of manufactured products in their different stages of development. It would also, in some schools, include a limited amount of practice in chemical analysis, but would not include actual manipulations by the pupils in manufacturing arts. In "trade schools" technical education might be carried to a greater extent: the pupils would be taught some of the practical working directions of various trades, the handling of ordinary tools, and the modes of manipulation of various substances, and thus such schools would form an intermediate stage between ordinary schools and the workshop. Experience in the production of manufactured articles for sale will probably always be obtained in a manufactory alone.

As I shall have occasion to use the words "science" and "art," I will first state what I mean by them:—A science consists of laws, principles, and facts; an art consists of technical directions and manipulations; and the latter is in all cases based upon the former, although in some instances the connection between them may not be well understood. Thus we have the science of electricity, and the arts of electric telegraphy and of electro-plating based upon it; and the sciences of heat and chemistry, with the arts of ventilation, photography, soap-making, iron-smelting, &c., depending upon them. In science, the great aim is truth and accuracy; in art and manufacture the chief object is to produce the best practical result at the lowest possible cost.

Every special art or manufacture consists essentially of some particular process, or series of operations, generally reduced to the greatest degree of simplicity in order to lessen the cost of production. In each different trade or manufacture a knowledge of the process is implicitly embodied in a number of instructions and details with which each workman is supposed to be fully and familiarly acquainted. Each manufacture is an art, the methods of which are based upon definite scientific facts and principles. What an English manufacturer generally expects of a workman is not a knowledge of the science or sciences upon which his manufacture is based, but a knowledge of those empirical methods, and ready practical experience in their use. In accordance with this expectation an English workman usually possesses a knowledge of the empirical methods or directions of his trade, but rarely understands their scientific basis: for example, a brass dipper knows that the methods for cleaning a figured piece of brass is to dip it into aqua-fortis, but does not understand the general chemical relations of acids and metals, or the special chemical effects of aqua-fortis on brass. The empirical methods of his trade, without which a workman could not work at all, have of necessity always been taught him, but a knowledge of their scientific basis, which would enable him to work to the greatest advantage, has been greatly neglected.

In some cases this blind following of methods, sometimes called "the rule of thumb," is sufficient, though very imperfectly so, for the manufacturer's purpose, which is to make the production of his goods as much as possible a *matter of routine;* but in most trades the following of empirical rules alone very frequently does *not* lead to the desired perfect result, the articles produced are imperfect, and then it is that a knowledge of science is necessary to enable the manufacturer or his men to avert or correct the evil. In such cases under present arrangements the manufacturer frequently finds fault with the materials supplied to him, or he sometimes applies to a scientific man for advice. In many cases, also, the following of those rules does not lead in the *best way* to the desired result, the materials, time, or labour are not used in the most advantageous manner, and the cost of the finished article is thereby made too great.

The selection of materials for manufactures by the "rule of thumb" alone leads to equally imperfect results. Nearly every manufacturer is aware by painful experience of the great and almost incessant variation that occurs in the quality and properties of the materials used in his trade, and the consequent frequent risk of failure of his process. In the manufacture of iron, for example, the presence of much phosphorus, sulphur, or silicon in the ore is very detrimental to the quality of the iron produced from it; in the manufacture of glass, the least quantity of iron in the materials will seriously injure the colour of the product; in the selection of copper for telegraph wire, if it contains the least trace of arsenic, the wire will not conduct the electricity properly. The difficulties experienced in getting suitable materials for a manufacturing process are in some cases very great; and when they are procured, additional difficulties arise from the inability of the manufacturer or his manager to analyze them.

Every manufacturer is also aware that the difficulties encountered in manufactures are not limited to the substances employed, but extend to all the different processes and stages of processes through which these substances have to pass, and to all the forces, tools, machinery, and appliances employed in those processes; in the manufacture of glass, for example, the greatest care has to be exercised in the making and gradual heating of the pots in which the glass is melted, the proportions of the materials, the construction of the furnaces, the management of the heat, and a whole host of minor conditions too numerous to mention, all of which must be attended to with the greatest care. In the manufacture of iron and steel, the smelting of copper, the refining of nickel, the preparation and baking of porcelain, and in many other trades, innumerable difficulties, all having their origin in the properties of matter and forces, continually beset the manufacturer. In some cases difficulties occur which perplex both the workman and the scientific man called in to his aid, and so far from an unscientific workman being able to overcome them, even with the aid of the scientific man, he is unable to do so.

The phenomena and changes which take place in matter and forces in nearly every manufacture are far more complex than men in general have any conception of; for instance, simply in heating a bar of iron to redness, a whole series of changes occur in its structure, its magnetism, its dimensions, its cohesive power, its specific heat, and its electric conducting-power, in addition to its absorbent power ("occlusion") of gases from the fire, and its superficial oxidation; the internal changes which occur in even so simple a phenomenon as this are so numerous, as to produce the impression that the substance is endowed with vitality. All these phenomena are doubtless only a very few of the number which really occur in this substance. Faraday said of physical and chemical phenomena, "the little that is known is a great and wonderful indication of that which is to be known."

The hidden difficulties which beset a manufacturer are not unfrequently so inscrutable that the present state of knowledge in science fails to explain them. Who can tell why it is that wire-work of brass or german-silver becomes gradually brittle by lapse of time? or why varnish made in the open country has different properties from that made in a town? or why silk dyed in Lyons should possess a finer colour than the same silk dyed by the same process in Coventry? With our present extremely imperfect knowledge of Physical and Chemical science, we can perhaps hardly form an idea of the infinitely complex nature of the phenomena which it presents.

One of the inevitable results of all these difficulties in manufacturing processes and of unscientific management, is the production of a large amount of goods of an inferior quality; and useless goods, technically called "wasters," the cost of which has to be laid upon the saleable ones, and thus the price of the latter is enhanced to the consumer. For instance, flint glass discoloured by iron has sometimes to be sold at a loss for making common enamel; waste window-glass has to be sold as "rockery" for ornamenting gardens, and defective articles of glass or metal have to be re-melted.

Many of these difficulties arise from the inaccuracy and carelessness of the workmen, and would be lessened by the more general diffusion of scientific knowledge. If workmen and managers had more preparatory scientific training, and all apprentices were suitably educated in science, not only would the foregoing sources of loss and expense be lessened, but workmen would acquire greater habits of caution, and such accidents as arise from the want of these in the management of steam-boilers, explosive substances, and mines, would occur less frequently. A miner never having seen an explosion of coal-gas and air in a scientific lecture, does not adequately believe or realize the dangerous nature of the mixture; and workmen in general in this country do not sufficiently believe in the fearful properties stored up in substances, and in the forces of nature, because they have not seen them demonstrated by experiments. It is a curse of the ignorant to be incautious in actual danger, and to suffer terror where no real harm can occur.

Many of our working-men are fearfully reckless in circumstances where a small amount of scientific knowledge obtainable by witnessing a few experiments would show them the existence of extreme danger. We read accounts of barrels of gunpowder being kept in blacksmiths' shops; of cans of damp gunpowder being set on a hob to dry; of nitro-glycerine being conveyed in a jolting cart, and of its being used to grease the axles of wheels; of a lighted candle being taken to a burst cask of petroleum, or into places known to be full of escaped coal-gas; of miners habitually carrying keys to open their lamps in the explosive atmosphere of coal-mines; and of men smoking pipes in barges laden with gunpowder. Frequent mishaps or accidents in the management of material substances are a sign of minds untrained in science.

Our working-men are also frequently very wasteful in the use of substances and forces; not having the skill to use them economically, they try to obtain increased quantity of results by a too liberal employment of means. In consequence of the greatness of our supply of coal, and a want of knowledge of science, British manufacturers have also been exceedingly wasteful of the force of heat. Coal differs from nearly all other abundant substances by containing within itself an immense store of power. Every particle of coal we use contains sufficient power stored up in it to lift itself a height of more than two thousand miles, or a pound of it contains enough power to lift a ton nearly a mile high.

There is no manufacture which does not continually involve a necessity for scientific knowledge. Every person who has to operate either physically or chemically upon material substances, or who has to superintend such operations, ought certainly to possess a general knowledge of the forces and materials under his care. A man who handles a substance should be familiarly acquainted with all its leading properties. Rational knowledge is far more valuable than empirical knowledge. A man who understands a principle can solve a new difficulty nearly as well as he can an old one. In the management and manipulation of materials it is manifest that a workman who possesses an intelligent knowledge of the principles of the processes, and of the properties of the forces and substances with which he is dealing, in addition to the every-day working experience, is better able to prevent accidents, correct errors, and vary the process so as to produce special effects; and must also, in many trades, be a better artisan than he who has only the daily working experience, guided by the "rule of thumb." In all manufacturing employments, science, combined with natural ability, is the only true foundation of skill. There is no kind of physical labour, however simple and rude it may be, in which superior intelligence does not enable a man to produce better or larger results. In most other human affairs the means employed are adapted to the object in view, but in the manipulations with natural forces and material substances in this country, men are nearly always employed who are largely ignorant both of the one and the other. Faraday, in his evidence before the Government Commission appointed to inquire into the state of science education in our large public schools, stated that "we cannot find the intelligent common man in this country."

What is really wanted in our workmen and managers is not the *substitution*, even in the slightest degree, of scientific knowledge for the knowledge of the special methods of their trades, nor even that they should be largely acquainted with some one branch of science, but that they should be much *more largely acquainted than they are with the leading facts and principles of the sciences upon which their own special arts and manufactures depend, and* that they should know *how such knowledge is applied and how these principles operate in their several occupations.*

With workmen and managers more scientifically skilled, all our machinery and processes would produce better and greater results, and labour and materials would be greatly economized. Instead of employing the present wasteful system, of making several unscientific attempts to produce an article, before succeeding, workmen would arrange their plans in a scientific and systematic manner beforehand, and thus be able to succeed in an undertaking at the first attempt. If workmen were more skilled, they might be entrusted with the care and direction of improved machines, by means of which labour and materials might be still further economized, and production increased to an enormous extent. That immense improvements remain yet to be made in our manufactures is shown by the fact that, even in the steam-engine, which is supposed by most persons to be so perfect, we only obtain less than one-tenth of the mechanical power producible by the heat contained in the coals, the remainder being lost in a variety of ways, largely within the machine itself.

Not only are workmen and managers in this country insufficiently acquainted with science, but their employers are as a rule nearly equally so, and simply because in the great majority of cases they have been educated in schools where science was not taught. Several manufacturers and large employers of labour have regretted to me the fact, that science was not taught them when they were at school. The general ignorance of science by our manufacturers is also shown by the absurdity of a large proportion of our patents. An advance in such knowledge must in most cases begin with the employers rather than with the employed, for it would be reversing the natural order and fitness of things for the workman to be better acquainted than his master with the employment: knowledge in general should descend from above.

A greater amount of knowledge of the general principles of science is desirable both in masters and men, and particularly of those sciences which relate to their trades. It is desirable in the workman, because he is most immediately in contact with the process, and could therefore more quickly detect a fault and prevent or remedy an accident, and also because he would be otherwise incompetent to understand and carry out the instructions of his master. It is a well-known and frequent complaint with some employers of labour that they cannot induce their workmen to vary or alter their process, even in cases where it is absolutely necessary; the workman in his ignorance opposing every improvement. A scientific workman is more likely than his master to suggest improvements in a manufacture, because he feels the wants or defects of the process, through being in immediate contact with it. A knowledge of science is also desirable in a master, in order that he may be able to intelligently direct his workmen in their difficulties. Under present circumstances, it not unfrequently happens that improvements suggested by workmen are ignored and discouraged by masters, in consequence of the latter being ignorant of science; and in this way numerous instances of dissatisfaction have arisen between master and man, and important inventions have probably been lost to the nation through want of proper trial. It was chiefly by the genius and ability of working-men that steam-engines, the cotton manufacture, and the whole system of modern machinery was developed, by means of which this nation has obtained such immense wealth.

It has been objected to me by some manufacturers, that "scientific workmen are conceited, unmanageable, and continually wanting to make alterations;" and there is a large amount of truth in these remarks. If scientific education was more generally diffused amongst workmen, a greater degree of equality of intelligence would exist, and the cause of conceit be removed. In many instances, where such workmen have been found to be interfering and desirous of making alterations, the annoyance has arisen not solely from the conceit of the working-man, but in part also from the ignorance of science by his employer.

It has also been remarked to me that "a little knowledge in a workman is a dangerous thing;" it might be much more truly said that still less knowledge is a still more dangerous thing. Knowledge we know imparts power, and power requires to be regulated; knowledge in a workman requires to be regulated by greater knowledge in his master; and if the kind of scientific instruction afforded to workmen whilst boys at school, be specially directed to an inculcation of the principles and leading facts of physical and chemical science, there will be but little risk of its being superficial.

It has further been objected to me by a manufacturer that "science is making workmen more mechanical, and is driving all skilled labour out of the field." Although there is some truth in this, it is not a correct view of the case, the large introduction of science into trade within the last century, in the shape of telegraphs, steam-engines, gas manufacture, electro-plating, the manufacture of machinery, &c., has created a much larger demand for intellectually-skilled labour than ever existed before; and so large is this demand that a great difficulty experienced by nearly all those who have introduced such inventions has been to obtain workmen possessing sufficient intelligence to manage their processes. It is also a well-known fact, and frequent complaint with manufacturers, that highly-skilled workmen are much too few in this country. The tendency of scientific improvements is to diminish the *physical* labour of the workman, but they require in its stead a greater degree of *intellectual* skill; they have mitigated his physical toil, by giving him the duty of intelligently directing the labour, instead of actually performing it. Workmen are now obliged to exercise the faculties of observation and judgment, in watching the results, and directing the action, of mechanical, physical, and chemical forces, instead of being themselves the physical machines, mechanically performing the work before them. A workman who is occupied all the day in laborious *physical* exertion, however great the skill required in that labour may be, arrives at his home at night in a condition fit only for sleep; whilst the man who directs a machine for performing the same labour is able after his toil to improve his mind by reading. Science has also increased the moral responsibility of workmen, by entrusting them with the management of all kinds of complicated and valuable machinery, requiring great care and exactitude of attention, upon the proper action of which the employment of many hundreds of workmen, and even the lives of numerous persons, not unfrequently depends; for instance, in the management of steam-boilers and engines. The lives of the whole of the passengers in a railway train also depend upon the skill and care of the engine-driver and fireman.

And it has been further objected to me by a manufacturer, that "science does not pay," or that "it does not pay anyone except a thoroughly scientific man; it does not, for example, pay a manufacturer or man of business." No doubt science, like everything else, benefits or pays only in its own special ways. With regard to this objection, we must distinguish between abstract scientific investigations made purely for the discovery of truth, without the slightest reference to personal profit, and investigations made for manufacturing or personal purposes; the former benefit the nation, but do not pay the investigator; the latter frequently benefits the manufacturer or person for whom they are made.

Scientific investigations made in a manufactory for the purpose of ascertaining the various sources of loss of materials, the circumstances which affect the amount or quality of the product; or made with the object of substituting cheaper or more suitable materials, or for varying their proportions, or for many other kindred objects, have in many cases resulted in great benefit to the manufacturer, and have formed in many instances the basis of successful patents. In confirmation of these remarks it may be stated that some of the large brewers, chemical manufacturers, candle companies, and many others, constantly employ scientific men to examine their materials, processes, and products, and keep them acquainted with the progress of discovery and invention in relation to their own particular trades.

The benefit derived by a manufacturer from a personal knowledge of science is largely of an indirect kind, and cannot therefore be measured in direct money value, like the profit acquired upon a given sale of manufactured articles. This knowledge improves his judgment in nearly all questions relating to material substances and manufacturing processes. Numerous instances might be collected where even a small amount of knowledge of science in a master, has in this way been of great value in the prevention of accidents in his manufacture or trade. It benefits the manufacturer also by improving his observing faculties, enabling him more readily to detect imperfections in the quality of raw materials supplied to him, to discern faults in the processes, and different stages of processes, through which his materials have to pass, and to detect imperfections in the action of the various forces, tools, machinery, and appliances employed in his manufacture. It gives him the ability of intelligently directing his workmen in their manipulations, instead of being the subject of their ridicule in consequence of his ignorance of such matters. It enables him to form a correct estimate of the feasibility and value of suggestions of improvements in his trade, made to him by his workmen or others, and prevents his being led by enthusiasts and designing persons to spend his money and time upon hopeless inventions. A want of knowledge of science, on the other hand, has ruined many manufacturers, who have been induced to embark their money in demonstrably fallacious schemes which could not possibly succeed; in proof of this we need only examine the lists of patents, and we there find numerous absurd projects which have been promoted by men of business.

Many persons ignorant of science expect too much from a knowledge of it; and from the remarks made to me by some manufacturers, they seem to think that a little knowledge of science would almost at once enable them to make improvements in their trades. Without such knowledge, undoubtedly, our trades and manufactures could not have attained their present degree of excellence, and by means of such knowledge improvements are also continually being made; but important improvements in trades, like other valuable things, are not so easily obtained; for every single successful improvement actually effected, many unsuccessful and sometimes costly experiments have been tried, which are partly lost sight of by some persons, and the successful results alone are noticed. Numerous instances might be adduced of large sums of money having been lost in scientific experiments made with the hope of improving various arts and manufactures; for instance, in the numerous unsuccessful attempts to properly lay submarine telegraph cables. The losses however, which occur in experiments scientifically made in this country, to improve manufactures, are extremely small, compared with those which result from unscientific attempts made with similar objects.

There may, perhaps, be some kinds of knowledge which are of more value to a manufacturer than that of science, but that is not a sufficient reason why the latter should be neglected. It may be of greater importance to him to have a manager who possesses a knowledge of workmen, and a good administrative power over them, than to have one who only understands the science of his manufacture; and it may be better for him to have a workman who understands the empirical methods of his trade, rather than one who knows only the science upon which those methods are based. Nevertheless, if English manufacturers are to successfully withstand foreign competition, they must employ workmen who can not only work, *but work to the greatest advantage.*

Not only is scientific education of advantage to a manufacturer, but it is also a national necessity; without it we are unable to fully economize the forces and materials employed in manufactures, or manufacture articles as cheaply as foreigners who bring scientific knowledge to their assistance. In some of the countries on the continent of Europe the national necessity of scientific education has been already recognized; not only is there a much more general diffusion of such knowledge in those countries than in England, but there is also a greater degree of State encouragement to scientific education. In Berlin a laboratory has been newly erected in the Dorotheen Strasse by the Prussian Government at a cost of 47,700*l.*, in Bonn another at a cost of 18,450*l.*, and in Leipsig a third large one is now being erected, at a cost of about 30,000*l.* In Carlsruhe, a noble building, the Polytechnic school, has also been erected, affording instruction to 600 science students. Having been over those buildings, and examined their internal arrangements, as well as the chief ones in this country, I can state that we have no laboratories, either erected by Government or by corporate bodies, which are equal to the foreign ones. Liebig, writing to Faraday, said, "What struck me most in England was the perception, that only those works which have a practical tendency awaken attention and command respect; while the purely scientific, which possess far greater merit, are almost unknown; and yet the latter are the proper and true source from which the others flow. In Germany it is quite the contrary." Germany possesses six purely technical universities specially adapted for the diffusion of "technical scientific education," whilst England does not possess one. It is a notable statement that "England spends five times as much on pauperism and crime as upon education; whilst Switzerland spends seven times as much upon education as on pauperism and crime." Each Englishman may be said to have to continually carry a pauper and a criminal in consequence of our neglect of education. For all our artisans—and they number by millions—there exists no means of scientific education which would specially fit them for their future employments. The Universities and Colleges are not for them, and in ordinary schools the principles and technical relations of science are but little taught. If England is to successfully keep pace with the progress of foreign intellect and foreign manufacture, there must not only be a general diffusion of elementary secular knowledge throughout this country, but there must also be as great a degree of encouragement of scientific knowledge as exists in other countries.

The desire to withstand foreign competition, and to recover lost trade and manufacture, are not the highest motives why masters and workmen should be induced to acquire a greater knowledge of science. It would be a higher virtue, and much more praiseworthy in all men, if they pursued truth primarily for its own value, and for the sake of their own mental improvement, rather than for the immediate pecuniary advantages it may confer.

It was not by means of better scientific education that our superiority as a manufacturing nation over other countries was developed, and for many years maintained, but chiefly in consequence of our abundant supply of coal and iron ore, and the genius of a few scientific men in applying those stores to practical purposes in steam-engines, machinery, and a multitude of mechanical, physical, and chemical processes. Had it not been for these circumstances, England, like other nations not possessing such stores, would have been compelled a generation ago to have adopted an extensive system of scientific education. The knowledge of science which has enriched this nation was not acquired in schools; its possessors had to get it as they best could. Where did Faraday learn electricity? Where did Watt learn the science of heat? How did Arkwright learn mechanics? They all obtained their knowledge in spare moments, not in our public schools, because those subjects were not taught in them.

Arguments are not unfrequently adduced to support the opinion that ignorance has its advantages; but, however great the advantages of ignorance may be, those of intelligence are still greater. The extent to which in this country ignorance of the duties of an office is considered a qualification for filling it, is in itself a melancholy proof of our real want of education.

In consequence of the labours of scientific discoverers and inventors, the progress of science is such that in a very few years a knowledge of it will be indispensable to all persons engaged in superintending or carrying out manufacturing operations, and in all arts, occupations and appointments in which man is dealing with matter. Science is fast penetrating into all our manufactures and occupations, and "those who are unscientific will have much less employment, and will be left behind in the race of life." England also will be compelled, by the necessities of human progress and the advance of foreign intellect, to determine and recognize the proper value of science as a branch of education.

The philosophy of matter is the foundation of all manufacturing arts and artistic processes; technical education, or the relations of science to manufactures, &c., can only be properly imparted upon the basis of a sufficient knowledge of theoretical science. An attempt to impart technical education without such a basis would be but a very imperfect improvement upon the present system of learning by the "rule of thumb" alone. It is true that our artisans can work and do work without scientific knowledge, but they cannot work to the greatest advantage; and it is precisely such knowledge they now so badly require. It would be difficult to state exactly how much of such knowledge should be imparted to intended workmen; but it should certainly include all the chief laws and principles of the sciences involved in their prospective employments. What persons in general, who are not intending to become teachers of science, require to learn, is rather the general principles and leading facts of science, and their relations to manufactures, than a large extent of science; the entire subject is altogether too great for them.

It is both unnecessary and undesirable that lessons in science should be entirely of an abstruse character, abounding in scientific terms difficult to understand. All such lessons should be freely illustrated by experiments, apparatus, models, processes, diagrams, drawings, and the use of the black-board; and the difficult terms necessarily employed in them should be fully explained. By selecting many of the illustrations from the applications of science in the phenomena of the material universe, of manufactures, and of every-day life, all the fundamental laws and principles of physical and chemical science may be readily made intelligible to the meanest intellect. By this method also, the theory of science and its practical applications may be simultaneously taught in the most natural and effective manner. In all scientific lessons to practical persons, suitable technical illustrations should be freely employed. Artisans have to deal, not so much with the laws and principles of substances and forces, as with the substances and forces themselves; and men who have to deal with matter and forces require not only the forms but the tangible realities of scientific knowledge. If an attempt is made to teach pure science alone without such illustrations, working-men and practical persons will not accept it, because they cannot perceive its application to their wants. What they specially require to be taught is, *how such knowledge is applied and operates in their several occupations.*

Each special manufacture usually involves the principles of several sciences, including physics and chemistry; and therefore the employments connected with it, and the technical education relating to it, also necessarily include a knowledge and an explanation of the chief laws and principles of those sciences: for example, the manufacture and working in metals requires a knowledge of the sciences of mechanics, heat, and chemistry; the occupation of electro-plating necessitates a knowledge of electricity and chemistry; the numerous employments involving the construction or use of tools and machinery require a knowledge of the science of mechanics, and in some cases also of heat and chemistry.

The fundamental laws and principles of any particular science operate in a similar manner in all trades, and are substantially the same for all learners: for example, the same chemical and electric principles operate in the galvanic batteries of telegraphists and electro-platers, as in those of the scientific investigator; the laws of combustion are the same in a puddler's furnace as in a domestic fire-place; water boils at the same temperature, whether it be in a chemist's flask, a brewer's copper, or in a servant's saucepan; the laws and principles of science, therefore, cannot be readily subdivided to suit particular trades. With the practical illustrations, however, the case is different; they may be selected from particular occupations, manufactures, arts, processes, and substances, so as to make the lessons suitable for different classes of persons, and thus *by varying the kind of illustrations* the lessons may be adapted to persons of different occupations, to agriculturists, metallurgists, and others. In courses of lessons or lectures on technology, the teacher should be very careful to select as many of the illustrations as possible from the actual working experience involved in the particular trades or occupations of his audience, and in this way the highest science may be united to the meanest art. A difficulty connected with the carrying out of this plan is, technical processes are rarely well understood by professional teachers, because those processes depend so much upon practical details.

The technological teacher must know both the science of the manufacture and the details of the manufacture itself to which that science is applied; he must be able to combine theory and practice, and continually to show the relation of abstract laws and principles to technical results. He must not only know how difficult things are done, but he must also to some extent be able to do them, and thus to teach by example as well as by precept. His teaching must be full of practical applications and familiar illustrations. Such teachers are as yet almost unknown, and Faraday, in his evidence already referred to, stated that the class of men suitable for teaching science remained to be created.

This statement made by Faraday still remains true. Our Universities have not yet supplied many schools with teachers eminent in physics or chemistry. The sudden public demand for some indefinitely understood scientific education has produced a supply of comparatively unqualified teachers, and those appointed in some of our schools have had only a book-knowledge of the subject, but little experience in making experiments, much less acquaintance with the relations of science to manufactures, and entirely without experience in original experimental research. The ignorance of some of the simplest practical scientific matters, shown by some of these otherwise educated gentlemen, has been quite astonishing, and the most charitable supposition is that they are unaware of their ignorance.

The kind of teachers required for communicating scientific instruction are not men possessed only of a book-knowledge of science, and the power of communicating it, nor even of men who have also repeated the experiments of others as described in books, but men who, in addition to all this, are familiar with the details of manufacturing operations, and have also had considerable experience in original experimental research, and thereby acquired the power of distinguishing truth from error in matters of science,—a quality of the highest value in teaching, and which cannot be acquired in any other way.

VIII. ATMOSPHERIC ELECTRICITY AND RECENT PHENOMENA OF REFRACTION.

By Samuel Barber.

Whatever connection may exist between earthquakes and electrical disturbance of the atmosphere — a connection remarkably substantiated during the past year—there seems little reason to doubt that there exists between the electric waves or currents and the condition of atmospheric vapour a close relation. The more we examine the various changes of cloud and mist, their multiform shapes and ever-varying tints, their changes in density, altitude, and attractive or repulsive power, the more are we convinced that a force of incalculable power and undefined extent, more subtle and scarcely less potent than that of gravitation is in constant operation upon them.

The operation to which I allude, that of electricity, both atmospheric and terrestrial, seems rather to have been studied in its exceptional manifestations, than as a force subject to law, and of vast and constant, though unobtrusive, influence. The difficulty of rendering this science deductive, in its relation to meteorology, is apparent; the collection of data and the progress of experimental research form our present basis.

Till something more is known, however, and known more definitely, as to the nature of cloud and fog constituents, we can scarcely expect much progress in this department; and I would commend the subject to aëronauts and microscopists. Mr. Proctor, in an interesting paper on the subject of rain,* quotes De Saussure, Kamptz, &c., against Sir J. Herschel and Tyndall, appearing to incline to the views of the latter writers. He does not, however, allude to electrical action in enumerating the causes of rain. Yet it seems to me there is no reason to believe that the aggregation or dissociation of clouds and the condensation of their particles is greatly due to the influence of this force. That the movements of cloud and mist are accompanied by strong electrical action has been shown by the experiments of Mr. Crosse, of Bromfield, and Mr. Ronalds;† and it is but reasonable to think that this action may have great influence on contiguous vapour, though unaccompanied by a disruptive discharge, or any luminous appearance. My observations induce me to think that electricity is also indirectly the cause of those peculiarities of refraction which depend upon the molecular condition of the vapour mediæ through which the light passes, *viz.*—Halos, Parhelia, Paraselenæ, &c.; and I may here remark that these phenomena appear to have been unusually abundant during the past year, which has also afforded such exceptional displays of aurora, &c.

On the 21st September, a halo, of large diameter, say 60°, corresponded in position with the cirrhus clouds which formed the refracting medium. This halo followed the irregularities of the cloud to a considerable extent. Its disappearance was almost instantaneous, being caused apparently by the approach of a large mass of cumulus in the lower region of the sky. Almost as soon as the latter touched the lower part of the circle, the halo vanished. The irregularities in the circle of light at one time took the form of a series of separate arcs, which bent inwards, and appeared to be composed of half-dissolved cirrhus. These irregularities of form were also very conspicuous in a remarkable halo which was seen on Friday evening, December 19th. This assumed a spheroidal form, and was intersected by streaks of cirrhus, which changed their form rapidly, and showed a prismatic refraction like that of the halo itself. The vanishing of the first-mentioned halo was perhaps caused by an alteration in the constitution of its crystals or vesicles resulting from the electric action of the cloud below.

The next appearance I have to describe was of a singularly beautiful form and perfect definition. It appeared imbedded in a mass of homogeneous vapour, and consisted of two distinct rings, the inner one of a deep cobalt blue. This ring was distant from the moon's disc about three diameters. Its outline was clearly defined, especially towards the inner part of the circle, and the colour was exquisite in tone. Farther from the moon, by about two apparent diameters, there was another ring, less defined and wider than the first, and of a beautiful crimson colour. Altogether this was the most beautiful appearance of the kind that I ever witnessed. It occurred about 11½ P.M. on the evening following that on which the first-described halo appeared. All three were followed by drenching rain, lasting about a week in the first case. A gale came shortly after the second (December 19th). The cirrhus clouds which almost filled the sky resembled in form an appearance of aurora on this occasion, and had a peculiar motion, vanishing and reappearing in fresh forms, though there was no wind at the time.

---

* 'Intellectual Observer,' December, 1867.

† *Vide* Sir S. Harris's 'Electricity.'

NOTICES OF SCIENTIFIC WORKS.

FARADAY, HIS LIFE AND LETTERS.*

One of the prettiest spots on the rail between Lancaster and Leeds is the village of Clapham. Here the bold Yorkshire scenery loses its nakedness, the hill-sweeps are cultivated, and a winding stream runs through the somewhat wooded valley. At a considerable elevation the railway bridges this valley, and as the station is neared a few scattered stone cottages mark the commencement of the distant village. This is the ancestral home of Faraday, and here his family name is still to be found. The Clapham parish register of 1708 contains the earliest record of the family of our great philosopher in the person of one "Richard Ffaraday." After this we find that at Clapham Wood Hall, there lived a Robert Faraday, one of whose sons, James, became a blacksmith. Soon after his marriage, in 1786, James Faraday moved to London, and lived for a while at Newington Butts, where his third child, Michael, was born on Sept. 22nd, 1791. This Michael was afterwards the "Faraday" whose name is now a household word, and the lustre of whose fame time will increasingly brighten.

The stages of Faraday's early life are well known; how, from being a newspaper boy, he rose to be a bookbinder's apprentice, then to be the assistant, and finally, the successor of Davy. It would, however, hardly be thought likely that the quiet and simple life of Faraday would furnish sufficient materials for so extensive a biography as that which Dr. Bence Jones has compiled. But it must be remembered that Faraday's life was full of his own stirring discoveries, and forms the link between the scientific men of the past and those of the present. The true function of a biographer is to sink himself in his subject, and this Dr. Bence Jones has done in an eminent degree. Hence the work reads like an autobiography. It gives us a picture of Faraday's intensely active and penetrating mind, from which there flowed at first sagacious letters to his friends; then a journal of foreign travel, full of acute observation; then a record of his early work in the laboratory; then his early triumphs as a lecturer; and, when he had fully trained himself for the fight, his grand conquests over the secrets of nature. So that one reads on with an eager and almost breathless interest as Faraday hotly pursues his electrical researches, and goes from strength to strength in the mysteries he reveals.

The first traces of Faraday's greatness of mind are to be found in his letters to his early friend Abbott. This correspondence, together with his foreign journal, occupy the main portion of the first volume. Most heartily do we thank Mr. Abbott for having preserved these letters. With all Faraday's disadvantages of education, his letters, though often laboured, it is true, are written with an elegance and thoughtfulness of which anyone might be proud. When twenty-one years old, he wrote the following passage to Mr. Abbott, in which at that age his discernment is well seen. How many would do well to listen to these words:—" A lecturer falls deeply beneath the dignity of his character when he descends so low as to angle for claps, and asks for commendation. Yet have I seen a lecturer even at this point. I have heard him causelessly condemn his own powers. I have heard him dwell for a length of time on the extreme care and niceness that the experiment he will make requires. I have heard him hope for indulgence when no indulgence was wanted, and I have even heard him declare that the experiment now made cannot fail from its beauty, its correctness, and its application, to gain the approbation of all. Yet surely such an error in the character of a lecturer cannot require pointing out, even to those who resort to it; its impropriety must be evident, and I should, and perhaps have done well, to pass it."

---

* 'The Life and Letters of Faraday,' by Dr. Bence Jones, Secretary to the Royal Institution. London: Longmans, 1870.

The first lectures that Faraday delivered were given at the City Philosophical Society in 1816. These were prepared with all the careful assiduity which marked his subsequent work. From the notes of these lectures we glean what Faraday was at twenty-four. Here are his thoughts at the close of one of these lectures:—" The philosopher should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biassed by appearances; have no favourite hypothesis; be of no school; and in doctrine have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of nature." More than fifty years have passed since these words were spoken, and now we perceive how perfectly Faraday himself realized this noble ideal.

From the journal he kept when travelling with Davy, we learn some interesting facts concerning the social as well as the scientific state of Europe at that time. Here, too, are to be found traces of his keen and accurate observation, of his humour, of his kindliness, and of his constant affection for those at home. In this journal one of the most valuable of his entries relates to the combustion of the diamond, a feat, it will be remembered, that Davy first accomplished at Florence by the aid of the fine lens belonging to the Grand Duke of Tuscany. Our readers may be glad of the extract:—

" To-day we made the grand experiment of burning the diamond, and certainly the phenomena presented were extremely beautiful and interesting. A glass globe, containing about 22 cubical inches, was exhausted of air, and filled with very pure oxygen, procured from oxymuriate of potash; the diamond was supported in the centre of this globe by a rod of platinum, to the top of which a cradle or cap was fixed, pierced full of holes to allow a free circulation of the gas about the diamond. The Duke's burning-glass was the instrument used to apply heat to the diamond. It consists of two double convex lenses, distant from each other about 3½ feet; the large lens is about 14 or 15 inches in diameter. The instrument is fixed in the centre of a round table, and is so arranged to admit of elevation or depression, or any adjustment required, at pleasure. By means of the second lens the focus is very much reduced, and the heat, when the sun shines brightly, rendered very intense.

"The instrument was placed in an upper room of the museum; and having arranged it at the window, the diamond was placed in the focus, and anxiously watched. The heat was thus continued at intervals for three-quarters of an hour (it being necessary to cool the globe at times), and during that time it was thought that the diamond was slowly diminishing and becoming opaque. . . . . On a sudden Sir H. Davy observed the diamond to burn visibly, and when removed from the focus it was found to be in a state of active and rapid combustion. The diamond glowed brilliantly with a scarlet light inclining to purple, and when placed in the dark continued to burn for about four minutes. After cooling the glass, heat was again applied to the diamond, and it burnt again, though not nearly so long as before. This was repeated twice more, and soon after the diamond became all consumed. This phenomenon of actual and vivid combustion, which has never been observed before, was attributed by Sir H. Davy to the free access of air. It became more dull as carbonic acid gas formed, and did not last so long. The globe and contents were put by for future examination."

Returning to England, Faraday was, in 1815, officially appointed to be chemical assistant at the Royal Institution. As such he continued for some ten years, when, having already given occasional lectures, first in the laboratory, and then in the theatre of the Royal Institution, he was permanently appointed to the position he held until his death. In 1816 Faraday published his first contribution to science in the then 'Quarterly Journal of Science;' this was rapidly followed by other papers on very diverse subjects, and it was not until 1831 he began the great work of his life, the 'Experimental Researches in Electricity.' It will be unnecessary to refer to these researches here, for our readers are probably acquainted with their magnitude and importance. Unswervingly were they pursued until, in 1855, he sent the thirtieth, and last, of the series to the Royal Society.

Remembering his even life, many are surprised that Faraday found it necessary to relinquish his great work at an age in which most of our statesmen are in their very prime. When, however, we recall the intense application of mind and body necessary for the pursuit of physical investigation, and how for forty years Faraday sustained this unceasing drain of nervous energy, our surprise is only at his powers of endurance, and that it should have been possible for one man to accomplish so much. Up to the very end he worked, even when his memory was fading away and his powers of mind so exhausted that he had at frequent intervals to rest his brain, until, like a voltaic pile, the nervous force accumulated with sufficient intensity to effect a discharge of thought. At last baffled at every turn by the loss of memory, his experimental work only ceased when, after completing a tedious and unsuccessful investigation, he found he had done it all before, and obtained the results he now sought for in vain.

His last thoughts were turned to the possibility of correlating gravity with the other forces. And, with all deference, we beg to express our regret that the Royal Society refused his last paper, in 1860, "On the possible Relation of Gravity with Electricity and Heat." The results, it is true, were negative, but to publish what cannot be done is, in science, often as valuable as to publish the records of success. Here are some of the speculations that are to be found in Faraday's note-book at this period. Speaking of gravity, he says:—"Might not two globes (or masses, as pigs of lead), A, B, attached to the end of a long rope, passing over a large pulley at the top of the clock-tower, or in the whispering-gallery of St. Paul's, serve an experimental purpose? Starting with both balls insulated, discharged, and balanced, then it would be easy to raise B and lower A, and examination by a very delicate static electrometer might show A charged positive and B negative; then discharging both, and reversing the motion, B would come down positive, and A become negative, and so on. . . . . These electrometers being very delicate and of the condensing kind, one man, having only to turn a windlass, might work the apparatus for half a day, or it might be kept in motion by a steam-engine, or other mechanical power. The evolution of one electricity would be a new and very remarkable thing. The idea throws a doubt on the whole; but still try, for who knows what is possible in dealing with gravity?" He makes the trial with all his accustomed experimental skill, and though he fails he does not despair that others will obtain results that are denied to him.

In connection with this subject of the correlation of forces an important extract, from the notes of a lecture delivered by Faraday in 1834, is given on p. 48, vol. ii. The notes run thus:—"Now consider a little more generally the relation of all these powers. We cannot say that any one is the cause of the others, but only that all are connected and due to one common cause. As to the connection, observe the production of any one from another, or the conversion of one into another." Then he states experiments, showing the conversion of chemical power into heat, into electricity, and into magnetism, and of the converse action in each case: after which he remarks:—"Even gravitation may perhaps be included. For as the local attraction of chemical affinity becomes attraction at a distance, in the form of electricity and magnetism, so gravitation itself may be only another form of the same power." Later in life Mr. Faraday initialed these notes and wrote 'Correlation of Forces.' Now Mr. Grove's 'Lectures on the Correlation of the Physical Forces' were delivered eight years subsequent to this. Hence priority of the idea unquestionably belongs to Mr. Faraday, whilst the masterly development that led to its speedy recognition was first accomplished by Mr. Grove.

The *chef-d'œuvre* of Faraday's researches is, in our opinion, that which led to the discovery of magneto-electricity. Both theoretically and practically its importance can hardly be over-estimated. It is well known that Faraday took a keen interest in all those developments of scientific discovery that benefited mankind. The writer well remembers the emotion with which Mr. Faraday spoke as he showed him a rod of iron that had been fused by a current of magneto-electricity, and explained the wonderful expansion of that power discovered by Mr. Wilde. Thirty years before, Faraday had seen the birth of that same electricity only in the convulsive twitch of the needle of his galvanometer. He lived to behold this child of his grow into a mighty power; he saw it everywhere employed and fortunes founded on its free use; he saw it adapted for telegraphy, and the luxury of private telegraphs made possible by its means; he saw it used on a grand scale for electro-metallurgy; he saw it generating ozone, and thereby refining sugar; he saw it make iron run like water; he saw its light used by the photographer to enlarge his negatives; and finally, he saw it shine like a midnight sun over the reefs around our coast. It is sad for our country's honour to know that the genius who laid the foundation of this prosperity was all his life long supported by a private institution, which never could afford to pay Faraday so much as he would have earned had he been a bank-clerk. It is humiliating to read how, when Faraday was rising to the zenith of his fame, the Committee of the Royal Institution were only able to report that "certainly no reduction could be made in Mr. Faraday's salary of 100*l*. per annum, with rooms, coals, and candles." And though, happily, Faraday found his highest reward in the pleasure of his work and in the kindly esteem of his fellow-men, nevertheless he keenly felt how little our nation care to recognize deep philosophical pursuits. Writing to Lord Wrottesley, he says,—"For its own sake the Government should honour the men who do honour and service to their country. I have, as a scientific man, received from foreign countries and sovereigns honours which surpass, in my opinion, anything which it is in the power of my own to bestow." What those honours were we had intended to state, but their astonishing number, some sixty or more—a number we believe quite unparalleled in the annals of science—would have occupied more space than we can spare.

In conclusion we must repeat our high opinion of the manner in which Dr. Bence Jones has compiled this record of Faraday. It has been a work of labour, but manifestly a labour of love. We wish the public would read this memoir. It would be well for themselves, and it would be well for the progress of science. No one can rise from the perusal of this work without feeling the better for knowing more of one who, as the following picture will show, embodied both "sweetness and light."

"As a philosopher, Faraday's first great characteristic was the trust which he put in facts. His second great characteristic was his imagination. It rose sometimes to divination, or scientific second sight, and led him to anticipate results that he or others afterwards proved to be true.

"As a man, the beauty and the nobleness of his character were formed by very many great qualities. Among these the first and greatest was his truthfulness. His noble nature showed itself in his search for truth. He loved truth beyond all other things; and no one ever did, or will, search for it with more energy than he did. His second great quality was his kindness. It was born in him, and by his careful culture it grew up to be the rule of his life; kindness to every one always—in thought, in word, and in deed. His third great quality was his energy. This was no strong effort for a short time, but a lifelong lasting strife to seek and say that which he thought was true, and to do that which he thought was kind.

"That one who had been a newspaper boy should receive, unsought, almost every honour which every republic of science throughout the world could give; that he should for many years be consulted constantly by the different departments of the Government, and other authorities, on questions regarding the good of others; that he should be sought after by the princes of his own and of other countries; and that he should be the admiration of every scientific or unscientific person who knew anything of him, was enough to have made him proud; but his religion was a living root of fresh humility, and from first to last it may be seen growing with his fame, and reaching its height with his glory, and making him to the end of his life certainly the humblest, whilst he was also the most energetic, the truest, and the kindest of experimental philosophers."

Such was the man of whom England has not seen his like since the time of Newton. A true Christian gentleman, a great High Priest of Nature was Michael Faraday.

Geology and Revelation: or the Ancient History of the Earth considered in the Light of Geological Facts and Revealed Religion.

By the Rev. Gerald Molloy, D.D. London: Longmans & Co. 1870. 8vo. Pp. 418.

It is no small credit to our Established Church that some of her best men have been also noted as our most able geologists.

Buckland, Conybeare, Henslow, Whewell, Sedgwick, and many others, have done credit alike to the Gown and to the Hammer.

Nor have the clergy of other denominations failed to furnish illustrations of geological workers and writers. The Rev. David Ure, the Rev. Dr. John Fleming of the Scotch Church, and the Rev. J. McEnery,[*] a Roman Catholic clergyman at Torquay, have largely aided in the promotion of geological science.

The author of the present work is also a Catholic clergyman and Professor of Theology in the Royal College of St. Patrick, Maynooth; where, being engaged in expounding the evidences of revealed religion, he met with difficulties in reconciling with them certain geological phenomena and speculations. He therefore resolved to make himself acquainted with the leading facts of the science, and for this purpose consulted the works of our great geological masters. He determined to consider the subject "in a candid and philosophical spirit," being, *however*, "impressed with the conviction that no fact can be really at variance with revealed truth."

The results of his inquiry he offers to those who, feeling like himself the necessity of it, have no time nor opportunity to pursue such an investigation.

In the present volume, Dr. Molloy treats of the bearing of the great antiquity of the earth, with the history that is given in Genesis. In a future volume he hopes to discuss the antiquity of man. His work is divided into two parts. The first is devoted to an outline of geological facts and phenomena. Contrary to the majority of authors who have treated of geology and religion, Dr. Molloy displays a very good knowledge of geological science, and this summary, which is written in a similar style to Page's 'Geology for General Readers,' can be read with advantage by those for whom our manuals afford too much dry detail. It contains the essential facts of geology, and is very agreeably written.

The second part of the work, the conclusions of geologists, are compared with the "truths of revelation." Dr. Molloy endeavours to adapt the periods of geology to the six days of Genesis—a subject that has already led to the publication of so many speculative books.

---

[*] Mr. McEnery's name will always be associated with the earliest exploration of Kent's Cavern, and the finding of human remains (in 1824–5) associated with hyæna, &c., in undisturbed deposits beneath the stalagmitic floor of this now historic cave.

The chronology of the Bible, he admits, does not go back to the beginning of the world. There may have been, he thinks, a long interval of time between the creation of the world, and the work of the six days. He regards the six days as probably of indefinite, though not necessarily of unequal length, and proceeds to arrange the geological formations into six divisions to indicate the different work done on each of the days. Apparently the seventh day is going on at the present time. Taking the history of organic life into consideration, he regards plants and trees as created on the third day (= Carboniferous Period); reptiles, fish, and birds on the fifth day (= Cretaceous, Jurassic, and Triassic Periods); and the beasts of the earth, including man, on the sixth day (= Tertiaries, &c.). The other three days were devoted to light, sun, moon, stars, &c., and we must not expect to find geological indications of them.

Respecting the fact that organic life, both plants and animals, prevailed upon the earth for many ages before the Carboniferous Period began, we need do no more than quote Dr. Molloy's ingenious answer:—"The sacred writer tells us, no doubt, that on the third day God created plants and trees; but he does not say, either expressly or otherwise, that previous to the third day the earth was devoid of vegetation.

"Again, we read that reptiles, fish, and birds were created on the fifth day. But there is nothing in the language of the inspired narrative from which it can be inferred that these several classes of animal life may not have been represented, before that time, by many and various species: though, probably, it was only on the fifth day that they were developed in such vast numbers, and assumed such gigantic proportions, as to become the most conspicuous objects of creation."

We have, in the foregoing brief notice, given some idea of the scope of Dr. Molloy's volume. If we could see the feasibility of arriving at any close agreement between geological facts and the history given in Genesis, we should welcome such a volume as this one, coming as it evidently does from an able and candid writer. But when a strained interpretation has to be put upon the one history so as to make it accord with the other, and especially when it is found needful to adopt such explanations as that above quoted, we cannot but feel that this, as well as almost every other attempt at dividing geological time into the procrustean limit of six periods, representing the six days mentioned in Genesis, helps us in no way towards a satisfactory concordance between the testimony of Moses and the testimony of the rocks.

A perusal of the first part of Dr. Molloy's work—especially the very impartial manner in which he discusses the facts and deductions arrived at by geologists—gave us a very favourable opinion of the book. We were disappointed, however, with the second part, and can only regret that the author has not done equal justice to the theological side of the question, if it can be said to have a theological side.

The question very naturally arises in our mind, Why should theology and geology be reconciled? has the one any ground in common with the other? The Bible was never intended to teach geology, nor the rocks ever intended to teach theology, save that they speak of unity of design, and uniformity of action in creation from the earliest times to the present day.

CHRONICLES OF SCIENCE,

Including the Proceedings of Learned Societies at Home and Abroad; and Notices of Recent Scientific Literature.

1. AGRICULTURE.

The sewage question has had its full share of attention during the past quarter. Before the Institution of Surveyors, the Society of Arts, and the London Farmers' Club, town sewage has been discussed as a possible source of profit to agriculturists and to ratepayers: and in the Report of the Rivers Pollution Commission, just presented to Parliament, it is discussed as a nuisance to be abated. In this report the agricultural remedy for the nuisance, being the only one by which it may be made a source of profit, is held out as trustworthy and efficient—but other remedies are also pointed out. Filtration—not the mere action of a sieve upon suspended matters, but filtration of the kind which venous blood undergoes when passing through the lungs—is a satisfactory remedy. If sewage be passed in an intermittent way downwards through a sufficiently capacious filter, displacing at each access the air with which the filter becomes filled in the intervals, it undergoes a thorough oxidation, and comes out with all its organic matter oxidized and rendered harmless. In this way, however, not only is a nuisance abated, but a valuable property is destroyed. All the agricultural analogies point to the fertilizing character of town sewage. Man ought to be as useful a species of farm stock as sheep. Everybody knows the fertilizing effect of the sheepfold. The 20 millions of sheep in England are the very safeguard of the permanent fertility of all our light soils. The 20 millions of "man"—for the two animals are singularly alike in number and weight—ought to be at least as valuable to the farmer. At present, man as farm stock is almost good for nothing. No doubt, the lesson which we are learning of his agricultural value at Edinburgh, Aldershot, Barking, Banbury, Warwick, Rugby, Bedford, Croydon, Norwood, Worthing, and elsewhere, will ultimately convince both town and country of the waste that is being now incurred. Perhaps the enthusiasm of those who believe in it, as well as the *vis inertiæ* of the incredulous, has had something to do with the dilatoriness of public opinion on the subject. It has been supposed that sewage will overrule the influence of climate, soil, and even the specific character of plant and animal. This however is a mistake. The proper conclusion is, that for most ordinary English agricultural crops of succulent growth, sewage, applied with discretion, is of unequalled fertilizing power; but for crops to which our climate is of only occasional and doubtful fitness, sewage, like other manures, will produce only occasional or doubtful results. The life and character of a plant are, in fact, an unalterable "quantity" in all agricultural calculations. They may be improvable within very narrow limits; but no enthusiastic belief in the power of any new agency in agriculture should blind us to the fact that, however animals and, *a fortiori*, men, who are capable of influence by many other motives besides the merely material ones, may improve under education, plants have very limited capacities indeed. We may educate our animals to some extent to bear with and perhaps to profit by an unaccustomed set of circumstances, but plants must be simply *selected* for their ascertained natural aptitudes. Happily there are plants enough for which our climate is well adapted by which we can most perfectly utilize the agency of sewage. Italian ryegrass, mangold wurzel, cabbages, celery, asparagus, and strawberries all prosper wonderfully under its influence; and even grain crops, judiciously treated, will answer satisfactorily to the sewage whip. We may hope, therefore, soon to see a profitable and wholesome conversion of town drainage, now so great a plague, into useful agricultural produce—good milk and vegetables, or even strawberries and cream!

The question of manure adulteration has occupied the attention of the Royal Agricultural Society of England, whose chemist, Dr. Voelcker, is now authorized to publish every month all analyses of adulterated foods and manures which pass through his hands: and accordingly several very glaring instances have been gibbeted in this way of worthless guanoes and superphosphates, in which gypsum, earth, chalk, and sand figure in place of the genuine ingredients of imported guano and bone-ash. This exposure of the risks which the farmer incurs by incaution in the manure market is the more necessary, when his success now more than ever seems to depend on brains and bones—his own brains, as the 'Agricultural Gazette' says, and somebody else's bones!

The current number of the 'English Agricultural Society's Journal' contains an interesting report of Belgian agriculture, from which, however, we do not gather any justification of the opinion which has hitherto been prevalent, that the small farming of that country is the best agriculture in the world. Of other communications which the Journal lays before its readers, we may name Dr. Voelcker's elaborate investigation into the value of beet pulp, the refuse of the beet-sugar manufacture, and his report of experiments which appear to indicate the usefulness of potash salts in manure for mangold wurzel. There are also reports on the cheese farms of Cheshire and on the American cheese factory system. Mr. Bailey Denton also calls attention in its pages to the possibilities of village sanitary economy in respect of water supply, cottage building, and drainage. And the Rev. J. Stratton calls attention to the social circumstances of the agricultural labourer, and the possibility of a comfortable maintenance for him without the aid of the poor law.

Among other subjects which have occupied the attention of farmers, both in agricultural periodicals and at the meetings of agricultural societies, have been—the management of grass lands, discussed before the London Farmers' Club; the influence of the moon on weather, plants, and animals, which was very fully discussed (the prevalent idea on the subject being shown to be mere delusion), before a Dorsetshire farmers' club; the impolicy of the game laws, and especially of the reservation of hares and rabbits on the part of the landowner; the need of some acknowledgment of tenant-right on the part of landowners in England as well as in Ireland, where the principle is fully acknowledged in Mr. Gladstone's Irish Land Bill; the prevalence of pleuro-pneumonia and foot-and-mouth disease among cattle, which has been very unusual both as to extent and as to severity; and the policy of improving the means of education for the agricultural labourer. The introduction of a Government Bill on elementary education—by which local authorities are required to enforce the attendance at public elementary schools of all children under twelve years of age who have no reasonable excuse for their absence—is a matter of great agricultural importance. Such a measure cannot fail to tell most beneficially upon the next generation of both labourers and their employers.

The agricultural statistics of the country for 1869 have been published during the past quarter. They indicate a considerable reduction in the number of farm live-stock. There were 70,000 fewer cattle, 350,000 fewer pigs, and no less than 1,110,000 fewer sheep in 1869 than in 1868. The horse stock has been this year for the first time enumerated, and we now learn that we have 1,141,996 farm horses at work in England, 1,561,061 altogether in Great Britain and close on 2,000,000 in the whole United Kingdom. Turning to the crop reports, about 340,000 more acres are returned as being in the hands of English farmers in 1869 than in 1868—23,370,639 acres in England, and nearly double that amount in the United Kingdom. There is an increase in England in the area of all grain crops amounting to 20,000 acres of wheat, 84,000 acres of barley, 22,000 acres of oats, 14,000 acres of rye, 45,000 acres of beans, and no less than 100,000 acres of pease. The clover crop was less in 1869 than in 1868 by no fewer than 365,000 acres, that being no doubt the extent which was ploughed up and sown chiefly with pease, but also with other crops, in consequence of the failure due to the drought of the year before last.

2. ARCHÆOLOGY (PRE-HISTORIC).

To whatever country the white man goes he carries with him, in addition to the blessings of Christianity, a string of evils which, sooner or later, destroy the aborigines from off the face of the earth. Alcohol, fire-arms, clothes, small-pox, measles, and many other noxious accompaniments of civilization have done their work upon the aborigines of America (as they have on those of Australia, Tasmania, and New Zealand), but the last fatal blow seems to have fallen upon them in the opening of the Great Pacific Railroad from New York to San Francisco. That which we hail as the harbinger of peace and good-will to men, this great highway for the nations, 3300 miles in extent, sounds the death-knell of the Pawnees and the Sioux, the Crows, the Arrapahoes and Cheyennes, as certainly as it threatens death to Mormonism. Both will in a few years be swept away.

Mr. Frederick Whymper, giving an account of the line in 'Illustrated Travels,'* says,—"In the neighbourhood of Cheyenne there is a large military station, Fort Russell, where some 900 soldiers of the United States' army are quartered, expressly for the benefit of the Sioux and those 'dogs of Indians,' the Cheyennes. The railroad lost some excellent engineers by the hands of the latter when the preliminary surveys for the line were being made. General Sheridan was enabled to surround several of their villages last winter, and killed and subdued a large number of them. Several hundreds thereby left this world for happier hunting-grounds. The General had the reputation, however, of treating the women and children with great humanity."† This is a sad picture to contemplate; but sooner or later the same thing will occur in New Zealand. In Tasmania one solitary old woman, named "Lalla Rookh," represents the last of the aborigines! The natives of Australia are driven into the wilderness. All the good and pleasant places, once their own, are occupied by our countrymen.

Dr. Haast has communicated to Professor Owen an interesting account of the discovery, in the province of Canterbury, New Zealand, of several cooking-pits and kitchen-middens, containing the remains of various species of *Dinornis*. Such conclusive evidence of the contemporaneity of this now quite extinct bird with man in this island is most valuable to the ethnologist, and leads him to hope for fuller details.

Mr. F. Spurrell has lately obtained from the neighbourhood of Dartford, Kent, several flint implements of the palæolithic type.

---

* Part XIV. Edited by H. W. Bates, Assistant-Secretary to the Royal Geographical Society. London: Cassell, Petter, and Galpin.

† Page 34.

At the Archæological Institute, Mr. Soden Smith recently (Dec. 3) gave an account of a Circle of Stones in Crosby, Ravensworth parish, Westmoreland. This was remarkable as being composed of three concentric circles, and having also an avenue of stones 112 yards in length leading to it, and two smaller groups of stones lying close to it.

The Rev. Greville Chester described the shell-implements and other antiquities of Barbadoes. These shell-implements occur in old raised benches, and are often very abundant; they are formed from the columella of *Strombus gigas.*

ETHNOLOGICAL SOCIETY.

President, Professor T. H. Huxley, LL.D., F.R.S. Lieut. Oliver, R.A., has laid before this Society (Dec. 7) an excellent Report on the Pre-historic Monuments of the Channel Islands, of which he has communicated the most interesting features in the first article in our present number. An ancient Calvaria, assigned to Confucius, was exhibited and described by Professor Busk. This calvaria was formerly set in gold and mounted on a tripod, and intended for a drinking vessel. It was taken from the Emperor of China's Summer Palace at Peking. Four figures have been discovered upon the skull in faint relief. The president (Professor Huxley) mentioned that the Australians still use calvariæ ornamented in a like manner. Major Millingen communicated an account of the "Koords and Armenians," and identified the modern Koords with the ancient Karduks mentioned by Xenophon. The language spoken in Koordistan is distinct from either Turkish or Persian, and is divided into numerous dialects. The Koords are described by the author as a wild and faithless people, rejoicing in plunder and slaughter, the females engaging in brigandage. As a race they are remarkably handsome, and exhibit a great variety of complexion, a dark skin with black hair and black eyes being most common; light hair and blue eyes however are also met with.

On January 11, Colonel Lane Fox gave an account of the "mere," or "pattoo-pattoo" of New Zealand, showing that it is used as a weapon for thrusting, not as a club; the author believes it to be a modified stone celt, as a series of transitional forms may be traced connecting the two implements. Colonel Lane Fox's opinion is confirmed by a letter from the Rev. J. W. Stack, of Kaiopoi, to Dr. Hooker, C.B., explaining that the "mere" is always used for thrusting, not for striking.

Dr. Haast, F.R.S., sends details of the discovery in New Zealand of a polished stone chisel and a sharpening stone, found by a party of miners, in an auriferous "lead." Advancing inland, from the present shore, several distinct belts of land (old sea margins?) may be observed, each characterized by its own peculiar vegetation; it was in the fourth of these belts, at a distance of 525 feet from the present high-water mark, that these implements were found. Although the polished implements are more highly finished than the rude chipped weapons hitherto found in or near moa-ovens,* the author considers they may have been used simultaneously by two races coexisting in the island, the more civilized using polished tools and dwelling on the coast, whilst the ruder primitive race retreated inland, retaining the use of their unpolished implements.

Dr. Oppert gave an account of a small race, numbering only about 50,000 souls, and known as the "Kitai," or "Kara-kitai," dwelling near the Caspian Sea, in the Russian Government of Derbend, and in the Siberian district of Guldja. These are the last descendants of a once powerful race, which ruled over China and Central Asia; one of their princes, Yelintashe, the author identified with the celebrated Prester John.

On January 25, Mr. Bonwick gave a paper "On the Origin of the Tasmanians Geologically considered," in which he sought to explain the distribution of many of the dark-skinned races in the southern hemisphere by an ideal southern land from whence they may have radiated. Dr. Hooker pointed out that man and the higher animals probably did not pursue the same line of migration as that followed by plants; and Professor Huxley suggested that a chain of islands may have formerly extended from New Caledonia to Tasmania, similar to that which now extends from New Guinea to New Caledonia, and that by this means a low Negrito type might have spread eastwards over this area.

Two papers followed: by Mr. Howorth, "On a Frontier-line of Ethnology and Geology," and by Mr Atkinson, "On the Nicobar Islanders." Mr. Atkinson exhibited some grotesquely-carved wooden figures brought from the Nicobar Islands by Captain Edge.

On February 8, Mr. W. Boyd Dawkins gave the history of a find of flint-flakes, and flakes of chert discovered in the angular *detritus* beneath a submerged forest at Porlock and Minehead, West Somerset. These objects of human workmanship prove that man must have existed on this old land-surface before the destruction of the forest and the accumulation of the series of overlying deposits. The author considered these flakes to belong to an early stage in the Neolithic period. Dr. A. Campbell read some notes on the remains of pre-historic man found in the neighbourhood of the Crinan Canal, Argyleshire. The Rev. Mr. Mapleson described these remains, which comprise some curious cup-shaped cavities and concentric rings rudely sculptured on certain stones; there are also menhirs and numerous cairns; crannoges have been found in most of the lochs, but they are usually solitary dwellings. Several duns, a vitrified fort, a brough, and a flint manufactory were also enumerated among the remains met with in this district. In connection with Professor Busk's paper "On a Calvaria" (read Dec. 21), that gentleman, on the 22nd February, exhibited another calvaria from China, lent by Dr. Lockhart. This skull is mounted in copper, and was formerly supported on a tripod and furnished with a lid.

---

* See Chronicle of Archæology for October, 1869, p. 513.

On the same evening Mr. C. Monkman gave an account of "Discoveries of Archæological interest in recent Deposits in Yorkshire." Worked flints have been met with in the clay of Kelsea Hill. Large finds of stone implements of neolithic type are said to have been made in the York sands. Many implements have also been found in the old river-deposits in the Vale of Pickering, opened for land-drainage works.

A paper by Dr. Jagor, the well-known Eastern traveller and author, was then read, "On the Natives of Naga, in Luzon, Philippine Islands," in which the author described in detail the manners and customs of the Bicol Indians inhabiting this locality.

ANTHROPOLOGICAL SOCIETY.

Dr. Beddoe, President. Dec. 7, Dr. Leitner described his visit to Dardistan in 1866, and gave some account of the Shina race. Although the Dards were at war with the Maharajah of Kashmir, Dr. Leitner was able to keep up friendly relations with them during his stay at Ghilghit, and to collect much material relative to the hitherto unwritten Dardoo dialects. The customs of these peoples differ greatly from those of Mohammedans or Hindoos. They do not appear to possess any religion or rites, save the placing of a stone by each person annually on a cairn. Their food was stored in caverns, each family possessing its separate depository.

Dec. 14. Mr. Wake, "On the Race-affinities of the Madacasses," argues for the unity of origin of the light and dark tribes inhabiting Madagascar, both the Hovas and the other race having a common language and customs. Mr. Wake thinks Madagascar must formerly have been connected both with the African continent and the Malay Archipelago. The natives possess the ox, the sheep, and fowls in a domesticated condition (the dog is not mentioned); they have also a knowledge of smelting and working iron. The author conjectures that Madagascar was perhaps the seat of man's primitive civilization.

On the 4th January Mr. L. Owen Pike, M.A., communicated a paper "On the Psychical Elements of Religion." The author discussed the elements of popular creeds; the religion which appeals to the emotions and to the intellect; the religion of the astrologers; the personification of natural objects and forces, human passions and human faculties ; brute worship ; the worship of humanity ; the philosophic creeds, and their connection with popular creeds, &c. The Ethnological Society announced by their Honorary Secretary, Colonel Lane Fox, that a statement which had been published to the effect that the Ethnological Society was about to be wound up, was unfounded. That Society owed nothing, and was never in a more flourishing condition.

The Annual General Meeting of the Anthropological Society was held on the 18th January, Dr. John Beddoe, President, in the chair. The Society is at present overshadowed with the loss it has so recently sustained in the death of its most active promoter and founder, Dr. James Hunt. No anniversary dinner this year cheered their proceedings. Those philanthropic souls who labour only to promote the happiness and freedom of mankind would have listened with pain on February 1st to Major F. Millingen's account of "Negro Slaves in Turkey." These unfortunates are brought from the countries situated on the higher basin of the Nile,—the Nile-valley being the route followed by the cargoes of slaves on their way to the markets. Major Millingen considers that so long as the demand and supply exist it is useless to hope that slavery can be abolished. The endless feuds of the Negro races keep up the supply, and the religious and social system of the Mussulman nation causes the demand. Sir Samuel Baker's expedition to put a stop to the slave trade will, the author considers, prove futile unless the Sultan and the Khedive intend really to do away with slavery, which the Major thinks cannot be accomplished unless they give up their harems.

At the meeting of Anthropologists, on February 15th, Dr. Barnard Davis and Mr. E. A. Welch gave an account of "The Aborigines of Chatham Islands." The aborigines of these three islands, which lie to the eastward of New Zealand, have been gradually exterminated by the invasion of the Maories. Dr. Barnard Davis gives the result of an examination of the skulls and skeletons of many of the inhabitants. The stature of the Moriories, or Chatham Islanders, indicated a race shorter and stouter than the inhabitants of New Zealand.

Dr. J. Campbell contributed a paper "On Polygamy: its Influence in Determining the Sex of our Race, and its Effects on the Growth of Population." The author, who had been many years resident in Siam, concludes that the proportion of males and females born were, as in the case of monogamist marriages, entirely equal.

Mr. Ralph Tate described an inscribed rock on the banks of the Iguana, a tributary of the Orinoco, presenting incised markings of a date more ancient than the present inhabitants of the district.

(*Including I*

The dismissal of M
Imperial Observatc
been familiar with
his rough and unc
of his colleagues a
in a jealous spirit
Recently he had
astronomes adjoint
ment before the M
Leverrier through
length. They fin
missing Leverrier
consideration, he s
has been appointe
of Imperial Astron

Though one c
an astronomer sh
which in a scientif
that the punishme
ever eminent, can
which scientific in

Mr. Lockyer
esting paper "On
a letter of Dr. I
by the photogra
moon is not the
mosphere. This
directions of ma
beams of the cor
last were variab
sponding to the s
on the photogra
these directions
total obscuration
relation to the
photographs is r
paper Mr. Lock
has before sugge
he fails to show
and the region
supposing it to
disc. Accordin

3. ASTRONOMY.

(*Including Proceedings of the Astronomical Society.*)

THE dismissal of M. Leverrier from his position at the head of the Imperial Observatory at Paris has not surprised those who have been familiar with the progress of events under his *régime*. By his rough and uncourteous manner he had alienated the good-will of his colleagues and subordinates; while by restrictions conceived in a jealous spirit he interfered with the progress of their labours. Recently he had given more tangible cause of offence; and the *astronomes adjoints* took advantage of the lapse to bring a statement before the Minister of the Interior, in which the conduct of Leverrier throughout his administration was discussed at great length. They finally submitted to the Minister the choice of dismissing Leverrier or accepting their resignations. After a brief consideration, he selected the former alternative, and M. Delaunay has been appointed to succeed Leverrier in the important position of Imperial Astronomer.

Though one cannot but regret that so distinguished and skilful an astronomer should have been thus dismissed from a post for which in a scientific sense he was so well fitted; it cannot be doubted that the punishment was well merited. No scientific ability, however eminent, can be pleaded in justification of a line of conduct by which scientific interests suffer.

Mr. Lockyer has communicated to the Royal Society an interesting paper "On the American Eclipse Observations." He quotes a letter of Dr. B. A. Gould's to show that the evidence afforded by the photographs suggests that the radiance seen around the moon is not the corona at all, but actually the image of the chromosphere. This is shown by many different considerations. The directions of maximum radiance do not coincide with the great beams of the corona; they remained constant also, whereas these last were variable. "There is a diameter approximately corresponding to the solar axis, near the extremities of which the radiance on the photographs is a minimum, whereas the coronal beams in these directions were especially marked during a great part of the total obscuration. The coronal beams also stood in no apparent relation to the prominences, whereas the aureole seen upon the photographs is most marked in their immediate vicinity." In this paper Mr. Lockyer expresses the opinion that the corona, as he has before suggested, is merely an atmospheric phenomenon, though he fails to show how the atmosphere which lies between the eye and the region near the eclipsed sun can be illuminated, or why, supposing it to be so, the glare should not trench on the moon's disc. According to ordinary optical considerations the blackness of the moon on the corona would indicate that the glory of light comes from a region beyond the moon.

Professor Tait has put forward a theory respecting comets' tails which deserves mention, though it can hardly be accepted as explanatory of even the more ordinary cometic phenomena, still less of the abnormal phenomena which many comets have presented. He considers that the visibility of a comet's tail may depend on the position of the earth with respect to the plane in which the meteoric components of the tail are travelling. When the lines of sight from the earth are directed at a considerable angle to this plane, the tail would scarcely be visible at all; but when the earth moves into any plane touching the surface in which the meteoric particles are for the moment mainly gathered, the tail becomes visible at once along its entire length, "just as a distant flock of sea-birds comes suddenly into view as a dark line when the eye is brought by their evolutions into the plane in which they fly." Professor Tait does not show that the appearance of any comet's tail *has* corresponded to the earth's assuming such a position as he describes; and there is a further objection to his theory in the fact that the tails of many comets have been visible for months at a time, whereas the earth cannot have been so long in the plane of meteoric aggregation unless that plane coincided with the ecliptic, which has not been the case in any known instance.

Dr. Balfour Stewart has brought before the Astronomical Society certain views respecting the "Aurora," which belong more properly to the Chronicle of Physics than to that of Astronomy. But a suggestion thrown out in that paper as to the nature of the Zodiacal Light must not be left unnoticed here. He asks whether this Light may not be a terrestrial phenomenon—as Mr. Lockyer has suggested. "When once the anti-trades have reached the upper regions of the atmosphere, they will become conductors from their tenuity; and as they pass rapidly over the lines of the earth's magnetic force we may expect them to be the vehicles of an electric current, and possibly to be lit up as attenuated gases are when they conduct electricity. May not these form the Zodiacal Light?" The answer to this question cannot but be negative. A phenomenon which rises and sets, which occupies in all latitudes a definite relation to the fixed stars—in respect of position, cannot by any possibility be a terrestrial one. The region of the counter-trades may perhaps be lit up as Dr. Stewart suggests; if so the whole sky would show the light, and we have here perhaps a satisfactory explanation of the phosphorescent light often visible over the whole heavens at night. But the counter-trades cannot throw a tongue of light over a definite region of the celestial sphere, nor can they regularly *set* on spring evenings and as regularly *rise* on autumn mornings.

In a paper communicated to the Royal Society, Mr. Proctor describes a peculiar motion of the stars, which he terms *star-drift.* According to the accepted theory of stellar distribution, it would follow that among the stars visible in any given region of the heavens there should be proper motions in all possible directions, and ranging through all orders of magnitude from zero to a certain definite maximum. In place of this, Mr. Proctor finds that in many regions of the heavens the stars exhibit a certain community of motion, which seems to indicate that they form a set or system travelling bodily in a definite direction.

During the next quarter Jupiter will not be favourably visible, as he will be in conjunction with the sun on May 24th. Saturn, however, coming to opposition on June 16th, will for several months be a fine object for the telescopist. The rings are now at their full opening, and though the planet will be low down, yet in favourable weather it may be studied with advantage. Venus will reach her greatest westerly elongation on May 4th, but her apparent diameter is rapidly diminishing.

The solar spots are now very numerous, and for the coming months the sun should be very carefully studied.

PROCEEDINGS OF THE ASTRONOMICAL SOCIETY.

Mr. Paine supplies an account of the total eclipse of August 7, 1869, which he observed in Boonesboro, Iowa. He noticed that the corona was not as striking as the one seen during the eclipse of November 30, 1834, nor was the darkness so great. He also remarks that the prominences were much more distinct last August than in 1834. He quotes the opinion of one who saw the total eclipse of 1806, that then also the flames were inconspicuous, and the darkness greater.

Commander Ashe describes the eclipse as seen in Canada; and Mr. Webb communicates an account of the work done by Professor Mayer in photographing the same eclipse. It is needless to enter into particulars respecting this communication, since, in a paper by Mr. Crookes in the last number of this Journal, a full account has been given, not only of Professor Mayer's work, but of that done by other photographers.

Mr. Alexander Herschel discusses certain irregularities presented during recent appearances of the November meteors. Observations seem to indicate the existence of two meteoric currents bordering upon the main-stream, but separated from it by blank spaces almost entirely devoid of meteors, and forming lateral outliers of the stream, near to which they appear to move in parallel and closely-adjacent orbits. "The passage of the earth through the first of these outlying streams occurs about twelve hours earlier, and its passage through the last about twelve or fifteen hours later than its appulse with the main or central current." From other communications respecting the November meteors, as seen last autumn, it would appear as though the distance of the outlying or lateral streams from the main zone had become very much greater, with the advance of the meteors over one year's arc.

Mr. Proctor supplies a note "On the Sun's Motion in Space, and on the relative Distances of the Fixed Stars of various Magnitudes." It had been noticed by Mr. Dunkin that when the sum of the squares of the stellar proper motions is compared with the sum of similar squares corrected for the effects attributed to the sun's motion, the effect due to the correction does not appear to be so large as was to have been expected. In fact the former sum is 142·0251, while the latter is 136·4917, the difference being altogether insignificant compared with either. Sir John Herschel had expressed the opinion that this result need not surprise us. "If the sun move in space, why not also the stars? and if so, it would be manifestly absurd to expect that any movement could be assigned to the sun, by any system of calculation, which would account for more than a very small portion of the totality of the observed displacements." Mr. Proctor shows, however, that the mere number of the stellar movements will not suffice to explain the discrepancy, since the motion of each other is affected by the sun's, and so the sum of the corrections is as much increased (through the effect of mere number) as the sum of squares. By aid of the integral calculus he proves that the correction should in effect be one-half of the uncorrected sum. He explains the discrepancy as due to the fact that the stellar distances have been incorrectly dealt with, the distances of the smaller stars being overrated. He finds in the observed proper motions of the smaller stars an independent proof of this.

Dr. Robinson suggests an ingenious method of imitating the transit of a planet over the sun. He obtains an artificial sun by placing a plate of brass, in which is a circular aperture, in the focus of a telescope. When this is illuminated by a lamp placed behind it, and viewed collinator-wise, it appears as a luminous disc 17′ in diameter. He obtains an artificial planet, either (1) by means of a small opaque disc, carried by the frame of a micrometer in the observing telescope, or (2) by means of an opaque disc placed within the aperture, and movable in its plane by a micrometer attached to the collinating telescope.

Mr. Stone supplies a paper on the increase of probable errors in a transit of Venus, as dependent upon the smallness of normal velocity. After showing that the differences in time observations made on the transit of Mercury in November, 1868, actually amounted to

13 seconds, he remarks that, so far back as April, 1869, he pointed out the ratio of the probable errors arising from this cause in the transits of 1874 and 1882.

In a paper on the same subject, Mr. Proctor points out that from Mr. Stone's observations upon the transit of November, 1868, it can be shown how the discrepancy of 13 seconds can be reduced to one of only the tenth of a second.

Mr. Birt describes the spots and markings on the floor of the lunar crater Plato.

The Assistant-Secretary, Mr. Williams, has just completed the translation of the Chinese records of comets observed from B.C. 613 to A.D. 1640. Some of the observations will probably bear important fruit, since no well-authenticated accounts of comets, seen so long ago, exist elsewhere.

Mr. Browning supplies a most interesting paper on a change in the colour of the equatorial belt of Jupiter. During the month of October last he noticed that this belt, which is usually the brightest part of Jupiter's disc, exhibited a strong greenish yellow colour, and was darker than the bright belts north and south of it. Other observers, using Browning's reflecting telescopes, have observed similar appearances. Indeed, it is worthy of notice that, not only these changes of colour, but the colours ordinarily present in the discs of Jupiter and Saturn have been only seen distinctly with reflectors. MM. De la Rue and Lassell, for example, have seen these colours with their fine reflectors, whereas Dawes, with all his astonishing powers of vision, and though he used refractors of exquisite defining power, has not been able to recognize them clearly, if at all.

Mr. Weston supplies an interesting note on the lunar Apennine range and adjacent regions.

Mr. Carrington describes his new Observatory at Churt, Surrey. The principal telescope is an alt-azimuth, constructed on a new principle, the horizontal axis being the effective optical axis. A movable prism, ~~placed~~ outside the object-glass, reflects the object along the tube. Thus the telescope need never be raised, and the observer can remain always under cover.

Mr. Proctor puts forward a new theory of the Milky Way. He regards this sidereal group as forming a spiral of really small stars, swayed into its present position by the attractions of the large stars which are seen on the galaxy.

Messrs. Airy and Simms have at length brought their new eyepiece to its simplest and most perfect construction. By the mere rotation of the eye-glass—which must be plano-convex—all the effects of the flint-glass prisms described in our last Chronicle can be obtained without any mischief to the optical performance of the telescope.

Mr. Proctor supplies a paper on the application of photography to determine the solar parallax from the transit of Venus in 1874. It is illustrated by fifteen pictures of the earth on her passage through the shadow-cone of Venus. The object of the paper is to show how photographs of the sun may be so taken, at different stations, that the relative displacement of Venus may be on a radius of the sun's disc.

In another paper he exhibits a method of constructing charts by which the great circle course between any two points on the globe may be accurately and quickly obtained.

Mr. Browning has invented a new form of micrometer for measuring the position of lines in faint spectra. By this arrangement an image of a bright cross is thrown on the spectrum, which it can be made to traverse by turning a micrometer screw. The advantages of the plan will be appreciated by those who know the difficulty of determining the position of the spectral lines by the usual arrangement.

4. BOTANY.

Influence of Climate and Soil upon Plants.—M. Kerner, of Innsbruck, has published a very interesting pamphlet on this subject, one of great importance in relation to the question of the origin of species. In the centre of distribution of a species, where it reaches its maximum of abundance, it is very unusual for varieties to become established; since, even if deviating forms were to appear, they would not be perpetuated, in consequence of the law of nature that cross-fertilization with other individuals, rather than self-fertilization, is the rule. On the outskirts, however, of the region of distribution, where the individuals are very scattered, a variation once appearing is likely to become established; because, the chances of self-fertilization being much greater, the peculiarities are likely to be perpetuated by heredity. Here therefore we must look for those aberrant forms which become the ancestors of new species. The author believes the direct influence of climate or soil in originating changes in the structure of plants to be extremely small; these changes being effected only in the course of many generations by the process of natural selection, those individuals which exhibit slight divergences suitable to the circumstances in which the plant is placed being most likely to survive, and to produce large numbers of seeds. Changed conditions of life can kill a plant, or destroy its health, but can have no direct influence in transforming it into a form more suitable for those conditions. As a contribution towards a series of observations on the relation between the flora of a country and its natural conditions of soil and climate, M. Kerner has paid special attention to the general features of the flora of the

Tyrolese Alps. Owing to the shortness of the period of activity of vegetation, which does not average more than from 1½ to 3½ months, few plants ripen their seeds before the return of constant frost. In consequence, while the proportion of annual plants is in the Mediterranean flora 42, and in that of the south-east of Europe 56 per cent., in the Alpine flora it is only 4 per cent. From the same circumstance the flower-buds of Alpine plants are commonly developed in the autumn before the return of frost, and burst into bloom immediately on the melting of the snow, before the appearance of the leaves. Another peculiarity of the Alpine vegetation is the very large number of plants with rosettes of stiff succulent or fleshy leaves, which both serve as reservoirs of food during the long winter, and are also proof against the sudden evaporation caused by the hot sun during the summer months. In contradistinction to this, is the almost entire absence of the bulbous plants which form so prominent a feature of the Mediterranean vegetation. Again, while the forests of tropical countries, where the summer is long and intense, abound with a luxuriance of climbing and creeping plants, these are almost entirely absent from the Alpine flora, where plants do not require to seek the shade.

Relation between the Distribution of Plants and of Animals.—Professor Delpino, of Florence, traces the gradual disappearance of many classes of plants as one proceeds northwards, to the absence of those animals, chiefly insects, which are necessary to effect their fertilization. In the Tropics many plants are fertilized by the agency of humming-birds, especially those possessing large trumpet-shaped flowers of a scarlet hue; and these are the first to disappear. Next follow those fertilized by the larger *Lepidoptera* and *Coleoptera,* as roses, peonies, the night-flowering *Sileneæ,* &c. In the Arctic zone those plants only can survive which are fertilized by *Hymenoptera* or *Diptera,* or by the wind; a few flies and midges, and a bee (*Bombus terrestris*) being the only insects found so far north as Nova Zembla. In the gardens near Florence are two species of *Lobelia,* one of which is abundantly visited by humble bees, and produces seed very freely; the other, notwithstanding its beauty and the abundance of its honey, is never visited by insects, and never bears seeds, but can easily be fertilized by artificial impregnation. Professor Delpino believes that in its native country it is fertilized by humming-birds.

Flora of Iceland.—Professor C. C. Babington read an interesting paper before the Linnean Society, January 20th, "On the Flora of Iceland." The most recent investigations have brought up the number of flowering plants indigenous to the island to about 450, of which all, with the exception of about sixty, are found also in Britain; all the remainder, with three exceptions, are natives of the European continent, chiefly of Scandinavia; there is no species of flowering plants peculiar to the island. No woods are now to be found in the country, although some existed recently; the trees were all birch; nor is there any trace of the former existence of pines, or of any other kind of forest-tree; extensive woods of dwarf birch-trees are found in several parts, and some shrubby willows. No grain of any kind is grown on the island. The north-west corner, which has been comparatively little visited, appears to enjoy the least inhospitable climate.

Flora of Round Island, Mauritius.—At the meeting of the Linnean Society, held March 3rd, Dr. J. D. Hooker read a very interesting letter from Sir Henry Barkly, Governor of Mauritius, on the flora of this very little-known dependency of the colony. The island is about 25 miles from Port St. Louis, and only about 3 miles in circumference and 1¼ mile across; but its flora differs from that of the Mauritius, not only in species, but also in genera and even in families, although the depth of the intervening sea is only 400 feet. The island consists of a mound of tuff about 1000 feet in height, but without any apparent crater, bare of vegetation in the lower part. Only about twenty-four species of flowering plants were gathered during the visit, of which more than one-half are not found in the Mauritius, including three species of palm, one of them 30 or 40 feet high, a *Pandanus* or screw-pine, and two species of ebony. The fauna is equally peculiar.

Movements of Chlorophyll.—A very interesting series of observations has been made by the French botanists, Prillieux, Rose, and Brongniart, on the apparently spontaneous movements within the leaves of plants of the grains of chlorophyll which constitute the green colouring matter. These grains had been noticed by previous observers to congregate under the direct action of light. M. Prillieux performed his experiments on a species of moss, a kind of plant which offers great facility for these observations, as the movements can be observed in them under the microscope without dissection, owing to their transparency. When the moss had been kept in the dark for some days, the cells presented the appearance of a green network, between the meshes of which was a clear transparent ground. All the grains of chlorophyll were attached to the walls which separate the cells from one another; there were none on the upper or under walls which form the surfaces of the leaf. Under the influence of light the grains change their position from the lateral to the superficial walls, the movement taking place, under favourable circumstances, in about a quarter of an hour. On attaining their new position, the grains do not remain entirely immovable, but continually approach and separate from one another. If again darkened, they leave their new position, and return to the lateral walls. Artificial light produces the same effect as daylight. A protoplasmic material is intimately associated with the grains of chlorophyll, causing them to move in masses of network rather than in isolated grains; and this protoplasm is supposed to be the vital and animating part of the cell.

Climbing Plants.—M. Paul Lévy sends from Nicaragua some interesting observations on climbing plants. Their vitality is something wonderful. M. Lévy tried many experiments upon them, and found that burning was almost the only effectual way of destroying them. If the stem is cut, they put out roots from their branches, and if these roots are cut off, they are reproduced even as many as eight times. This extraordinary vitality belongs, probably, only to the climbers of tropical countries, a large number of those observed by M. Lévy belonging to the genus *Bignonia.* Some species of climbers show a preference for particular trees on which to climb, refusing to attach themselves to some kinds, and clinging eagerly to others, in order to reach which they may have trailed for some distance along the ground. Some trees are always entirely destitute not only of climbers, but of mosses, ferns, orchids, and other epiphytes. All the climbers observed by M. Lévy turn from left to right, none from right to left, as has been stated by other observers.

Alternation of Generation in Fungi.—Some remarkable observations on this subject have recently been made by M. Gabriel Rivet. It was noticed as long since as 1806 by Sir Joseph Banks, that the proximity of the Berberry-tree appears to be a cause of the prevalence of the disease known as "rust" in the grain-crops of the neighbourhood. It has now been ascertained that one of the Fungi which produce the rust in cereals, the *Puccinia graminis*, and the Fungus which causes the well-known orange spots on the leaves of the Berberry, the *Œcidium Berberidis*, are in reality different forms of the same plant; the spores of each form will not reproduce itself, but the other form. In the commune of Genlis, department of Côte-d'Or, in France, a railway company has recently planted its embankments with Berberry-trees, and immediately afterwards the crops of wheat, rye, and barley in the neighbourhood became infested with rust. A commission being appointed to investigate the subject, reported that wherever the Berberries are found the grain-crops are more or less attacked by rust; where they do not occur the crops are free, and that the planting of a single bush of Berberry is sufficient to produce the disease where it has never appeared before.

Variegation of Leaves.—M. Edouard Morren reports some important observations on the variegation of leaves, which he attributes to a kind of disease, capable of being inoculated from one individual to another, and even to a different species. By grafting a variegated plant on another, the infection can be conveyed downwards, no doubt by the circulation of the sap, and can even be carried upwards from a variegated stock to a healthy plant grafted upon it. M. Morren states that the placing of a variegated leaf beneath the bark of a branch of a healthy plant is even sufficient to produce the disease. Variegation may be produced by various causes, debility in the seed, dampness of the ground, want of light, &c. It can be propagated by layers, buds, or grafts, but not, under ordinary circumstances, by seeds. Variegation is partial decoloration or want of strength to produce the green grains of chlorophyll; if the decoloration is general, it causes death. None of the higher plants, except a few which are parasitic, can exist if entirely deprived of chlorophyll; though a perfectly blanched branch may occasionally lead a parasitic life on the remainder of the plant.

Cultivation of Cinchona.—Many climates are now found to be adapted to the profitable growth of the *Cinchona*, or Peruvian bark. In addition to its introduction into St. Helena, reported some time since, it is now grown on a small scale in the Azores. In our own governments of Madras and Bengal its cultivation is rapidly extending. From a report recently published by Mr. C. B. Clarke, Assistant-Superintendent of the Botanic Garden at Calcutta, it appears that the increase in the number of plants at the Darjeeling plantations during the year ending March 31st, 1869, was 673,654, making in all over three million plants, belonging to the three species *Cinchona officinalis, succirubra*, and *micrantha*, the area covered on the 1st of April, 1869, being 965 acres. There is also a smaller Government plantation at Nunklow, in the Khasia Hills. The tallest plants grown at Darjeeling are 19 feet high. Mr. Broughton, chemist to the Cinchona plantations in the Madras Presidency, believes that all the sub-varieties are permanent, and have been produced by artificial hybridization; but that hybridization seldom takes place in nature.

The Chair of Botany at the College of Science, Dublin.—This appointment, vacant by the resignation of Professor Wyville Thomson, has been conferred on Mr. W. T. Dyer, author of 'A Flora of Middlesex.' A vacancy is thus occasioned in the Professorship of Natural History in the Royal Agricultural College at Cirencester.

5. CHEMISTRY.

A VERY unexpected fact has been published by Professor Wanklyn. It has usually been considered that the affinity of chlorine for the alkali metals was very energetic, and when it is remembered that antimony and arsenic burst into flame when introduced into this gas, it was reasonable to suppose that the reaction between chlorine and sodium would be even more violent. Mr. Wanklyn, however, has shown that when chlorine gas is passed over metallic sodium—even when the metal is fused, and, whilst in a state of fusion, shaken in contact with the gas, so as to expose the fresh metallic surface—there is no action. A glass vessel containing a piece of sodium was weighed, and after the transmission of chlorine, under the circumstances above named, it was re-weighed, and found to be practically the same.

Mr. H. C. Sorby has published a detailed account of some remarkable spectra of compounds of zirconia and the oxides of uranium. The phenomena which he has observed are very complicated, and reflect the highest honour on his philosophical acumen. Some of the peculiarities in the spectra of compounds of the oxide of uranium with zirconia, led Mr. Sorby and others, some time back, to conclude that they were due to a new elementary substance.

A rapid method for the quantitative estimation of sulphur in cast-iron and steel is a great desideratum in metallurgical laboratories. Mr. Eggertz has described a process, based upon the shade of coloration which small quantities of sulphuretted hydrogen produce upon pure silver, or certain alloys thereof. In a glass-stoppered bottle, a mixture is poured of water and sulphuric acid, to which is added the metal, reduced to the finest possible powder. There is then suspended, by means of a very fine platinum wire, in the bottle, without touching the fluid, a clean piece of metallic silver, the platinum wire being held squeezed between the stopper and the neck of the bottle. The metal dissolves, in a moderately warm room, within a quarter of an hour, so that the silver can be taken out and examined after that time. The author has, by means of a series of experiments, been enabled to construct a scale of numbers representing, according to certain shades of coloration, the quantities of sulphur found.

Naphthaline is a waste product occurring in large quantities in gas works. The problem is how to utilize it. Dr. Ott has examined its properties with this object. Pure naphthaline is similar in appearance to alabaster, cracks easily in the warm hands, and becomes negatively electric on being rubbed with silk. It melts at 174° F., and boils at 452° F. Molten naphthaline absorbs a large quantity of air, which is given off again on cooling; according to M. Vohl, this gas is pure oxygen. Molten naphthaline dissolves indigo with great facility, forming a dark-blue violet liquid, from which the indigo separates on cooling, forming fine shining needles like copper. The amorphous sulphides of arsenic, tin, and antimony are also readily dissolved, and likewise phosphorus, sulphur, iodine, the iodide and chloride of mercury, arsenious, succinic, benzoic, and oxalic acids. Professor Asa Gray has thoroughly tested and obtained satisfactory results, proving that naphthaline may be advantageously used in museums, herbariums, &c., instead of camphor, as a very effective protection against moths and other insects.

It appears that in the utilization of the cane sugar existing in Madder-root, there is a fair field of profitable experimental research still left open and untouched. Madder-root, and especially the Zealand madder, is rich in cane sugar, containing between 14 and 16 per cent. The extraction of this sugar, without interfering with the tinctorial value of madder, and by means different from those whereby that sugar is now utilized—*viz.* fermentation and making of alcohol—is a problem still to be solved. Some 10,000,000 kilos. of madder are, at the very lowest estimate, consumed annually, and the bulk of the sugar therein contained is utterly lost.

We have received, from Mr. H. N. Draper, a pamphlet, from which we learn that the use of methylated ether as an intoxicant, instead of alcohol, is very general in the counties of Londonderry, Antrim, and Tyrone. The quantity taken at one time is from two to four drachms, and the dose is repeated twice, thrice, or even four and six times daily. Mr. Draper treats the subject in its relation to the inland revenue, and also to insurance companies, the former suffering by the practice to the extent of 5666*l.* per annum, while the risks of the latter are increased by such an inflammable liquid being stored and handled by people ignorant of its properties.

As a new disinfectant M. Paquet proposes the use of thymol, the stearopten of the essential oil from *Ptychotis ajowan*, an umbelliferous plant growing in India. In the undiluted state, this substance is a caustic, and is used in dentistry for the cauterization of hollow teeth; its advantage in this respect being that it has not an unpleasant taste, and, being very aromatic, does not affect the breath as carbolic acid does. Its aqueous solution is a strong antiseptic, and possesses disinfectant properties in a very high degree.

MM. Sepulchre and Ohressir have perfectly succeeded in utilizing the slag of the iron blast furnaces for the manufacture of paving stones, which withstand a crushing weight of more than 400 kilos. per square centim., and have answered for the purpose of paving several streets at Brussels and Paris, and stood heavy traffic, far better than even the celebrated Quenast stones. The streets paved with this material at Brussels have a heavy gradient.

The fatty matter contained in sheep's wool, technically known as snint, is likely to become of considerable commercial importance. It contains some 40 per cent. of potassa; and when ignited this alkali becomes thereby intimately mixed with strongly-nitrogenized animal charcoal. M. Havrez points out the profit to be derived from the use of snint for the manufacture of prussiates and cyanides, and M. Schattenmann, prussiate and cyanide manufacturer at Bouxwillir, near Strasburg, states that results of experiments made with snint by him on large scale, are decidedly favourable to the use of that substance for the purpose alluded to. It should be observed that the quantity of snint contained in raw wool amounts to one-third of its weight; and that in 1867 there were imported into the United Kingdom 63,000,000 kilos. of raw wool from the Cape and Australia, the quantity of snint contained therein amounting to at least 20,000,000 kilos.

The use of hypophosphoric acid in agriculture for the purpose of destroying noxious insects has been proposed by M. Martin, for the destruction of the *Phylloxera vastatrix,* which makes great havoc in the vineyards. The makers of phosphorus obtain a quantity of this acid in aqueous solution, which is thrown away as waste; but since the transport of this waste liquid is too costly (it may be very usefully applied where it can be had with ease), the author describes a method of making hypophosphoric acid by the slow combustion of phosphorus. According to his experiments, 2 grammes of this acid dissolved in 10 or 12 litres of water, is a strong poison for all kinds of insects, and not only does not hurt plants, but actually does good by increasing the soluble phosphates in the soil.

The solution of oxide of copper in ammonia acts as an energetic solvent upon cellulose; this property is made use of by A. Jouglet to waterproof paper in the following manner:—A tank is made to contain the solution just alluded to, and the paper is rapidly passed just over and in contact with the surface of the liquid, by means of properly-placed rollers moving with speed. The paper, on leaving, is pressed between two cylinders, and next dried by means of so-called drying cylinders, similar to those in use in paper-mills. The short contact of the felty paper-tissue with the liquid gives rise to just sufficient solution of cellulose to form an impermeable varnish.

A process for the preservation of butchers' meat, invented by M. Georges, is now in use on the large scale at Monte Video. The meat, in pieces weighing from 2 to 50 kilos., is placed in a mixture of water, hydrochloric acid, glycerine, and bisulphite of soda. After having been steeped for some time, the pieces are taken out and dusted over with finely-powdered dry bisulphite of soda, and then packed in air-tight boxes, filled as full as possible. In this state the meat keeps fresh any length of time, and becomes perfectly fit for use—equal to fresh butchers' meat—by steeping for a short time in water to which vinegar has been added, and afterwards exposure to air; the price of the preserved meat, of which it would be easy to supply to London and to Paris daily over 10 tons, is from 50 to 60 centimes per kilo.

Hydrate of chloral, the new anæsthetic and sedative, is daily increasing in importance, and many processes have been given for its preparation: the best is probably that of MM. Müller and Paul. Their process consists in passing a current of dry and pure chlorine gas into pure and absolute alcohol, until the contents of the flask are, after about seventy hours, converted into a white and crystalline mass; when this operation is properly conducted, a large quantity of hydrate of chloral is obtained. Hydrate of chloral is readily sublimed, and may be thus obtained as a dry, snow-white, neutral crystalline powder. It does not exhibit any smell at the ordinary temperature of the air; it volatilizes slowly, without absorbing much moisture, unless it be placed in a very damp place; it fuses at 56°, boils at 145°, is completely soluble in a small quantity of water, and also soluble in alcohol, ether, chloroform, sulphide of carbon, benzol, and fatty substances. Its aqueous solution ought to be neutral to test-paper, and should not become turbid by a solution of nitrate of silver.

It is now proposed to make the reflecting surfaces of looking-glasses of platinum instead of tin amalgam or silver. M. Jouglet prepares the platinizing compound in the following manner:—Very thin platinum foil is dissolved in aqua regia, the solution carefully evaporated to dryness, the solid chloride next placed on a triturating marble, and gradually mixed with essential oil of lavender. When incorporated with the chloride, the mixture is placed in a porcelain capsule, and left standing for several days; the fluid is decanted from any sediment, and filtered. As flux for 100 grains of platinum the following ingredients are used:—25 grains of litharge and 25 grains of borate of lead, mixed and triturated together with about 10 grains of essence of lavender; this is next mixed with the platinizing fluid. After a layer of platinum has been formed upon the glass, it is fixed by burning it in by placing the glass in peculiarly-constructed muffles.

From a series of observations made at Monaco, on the shores of the Mediterranean, Dr. Gillebert d'Hercourt concludes that there is always on the sea-shore an atmosphere impregnated with saline particles; this layer of air has, at the above-named place, some 500 metres horizontal and 60 metres vertical extent. This impregnation of salt is due to what the author terms "pulverization" of the sea-water by the breaking up of the surf, and is not directly influenced either by barometric pressure, hygrometric state of the atmosphere, or temperature. This hydro-mineral dust, as it is called by the author, is, unless there happen to exist near the coast physical obstacles in the shape of high mountains, carried far away inland, and is not to be confounded with what is of more coarse nature, and termed "spray," which is only quite local and produced when a gale of wind blows. The author states that, even on calm days in winter, the atmosphere near Monaco is up to a height of 70 metres, and some few miles inland, impregnated with this hydromineral dust.

As a proof of the greatly-improved mode of manufacture of sulphide of carbon and its very extensive use, M. Contet states that in 1840 the kilo. of rectified sulphide of carbon cost 50 francs (2*l*.). In 1848 M. Deiss manufactured it, and sold it at 8 francs per kilo.; and now it may be had wholesale at 50 centimes the same quantity. As regards the purification, M. Sidot first re-distils the raw product, then shakes the distillate up with mercury until the latter becomes black, and this operation is so long repeated as the metal is affected by the fluid, or rather by any sulphur dissolved in it. Sulphide of carbon thus purified is freed from the fœtid odour it generally has, and exhibits a smell of ether. M. Cloeg renders commercial sulphide of carbon inodorous by leaving it for twenty-four hours in contact with half per cent. of its weight of finely-powdered corrosive sublimate, care being taken to shake or stir up this mixture. The mercurial compound combines with the substances which are the cause of the fœtid odour of this substance, and an insoluble compound is deposited. The liquid is carefully decanted, and after a little pure inodorous fat has been added, the sulphide is re-distilled by the heat of a water-bath. The sulphide thus obtained exhibits an ethereal odour, and is eminently suitable for the extraction of oils, fats, &c., from various substances, since on evaporation of the purified sulphide these matters are obtained in as fresh and pure a state as if the oils had been obtained by pressure.

M. Coupier has succeeded in obtaining fuchsine without the use of arsenic by the action of hydrochloric acid and iron, in small quantities, upon pure aniline and nitro-toluol, taking care to apply a suitable temperature. Commercial aniline and commercial nitrobenzol also yield the same result; and M. Schützenberger states that having been requested to test the results of this reaction, he has found that the aniline red obtained is identical with that ordinarily made, and declared it to be a salt of rosaniline. The yield is very fair, and somewhat larger than when arsenic is used.

A lengthy memoir on various processes for preserving timber has been published by Dr. Ott. From it we learn that the opinion that carbolic acid and substances containing it are effectual in preserving timber is erroneous. The real preservative action of the tar-oils is due, according to this author, to a greenish fluorescent oil that comes over at the last stage of the distillation. Direct trials with pyren and paranaphthaline do not yield successful results. The question whether tar (coal-tar) contains a sufficient quantity of the fluorescent greenish oil just alluded to, to justify the use of coal-tar for preservative purposes, is answered in the negative. The decay of timber, or peculiar transformation which makes it unfit for practical purposes, seems to be, in most instances, produced by the attack of fungi and lichens. The mouldering of wood is distinct from decay, it being merely a chemical process caused by the action of water with small access of air. None of the processes invented to preserve timber by chemicals are perfect. The most simple and practical method is the old, but, unfortunately, far too slow plan of properly subjecting timber to the action of air and water, as practised in ship-building yards. *A propos* of the method of preserving wood by impregnation with sulphate of copper, it may be interesting to know that by an order recently issued by M. le Maire de Douai, the bakers of that town have been prohibited from using the wood of old railway sleepers as fuel for their ovens, since many of these sleepers have been impregnated with sulphate of copper, and there is danger that some compound of copper might poison the bread.

Professor Morton has described the works at New York where oxygen gas is manufactured on the large scale. The works consist of retort-houses, engine-rooms, store-house, pumps for compressing gas in cylinders, and a gas-holder of 26,000 cubic feet capacity. The process is carried on as follows:—About 700 lbs. of manganate of soda are placed in the retort, and heated to the requisite degree; superheated steam from a boiler is then admitted for about ten minutes. Two equivalents of the manganate of soda and two of water react upon each other, the water combines with the soda of the manganate to form a hydrate of soda, the manganic acid is converted into sesquioxide of manganese, containing only half the proportion of oxygen, and the other half of the oxygen passes off in the free state. At the conclusion of this part of the process the steam is shut off, and the superheated air is admitted for about fifteen minutes, whereupon the sesquioxide combines with more oxygen from the air, and is re-converted into manganic acid, which again combines with soda. The retorts in each furnace are charged with 700 lbs. of permanganate of soda, and by the consumption of 2 chaldrons of coke, and with the labour of three men, 25,000 cubic feet of oxygen are made per day. It is now sold at $2\frac{1}{2}d.$ per cubic foot, compressed in reservoirs up to a pressure of 250 lbs. to the square inch. The gas is of excellent quality, and very pure.

6. ENGINEERING—CIVIL AND MECHANICAL.

Light Railways.—The great question of the day amongst engineers, at the present time, is the construction of light, or narrow-gauge railways. The enormous expense which has attended the laying-down of existing lines upon what is styled the "standard" gauge, and their comparative unremunerativeness, have naturally led to the consideration of how the existing want of increased facilities of communication can best be supplied so as to recommend new projects for railway extension to the confidence of capitalists and the public generally. The subject has also obtained increased prominence in consequence of the arrival of a Russian Commission to investigate the means of communication in this country, and who, together with many other foreigners of distinction, and leading English engineers and others, paid a visit last February to the little Festiniog Railway in North Wales. As this line has the narrowest gauge of any existing railway worked by locomotive power, some description of it here may not be inappropriate.

Festiniog Railway.—This line, which is 13¼ miles in length, extends from Portmadoc to the slate quarries in the neighbourhood of Festiniog. It is slightly under 2 feet in width of gauge, and was originally constructed for horse traction, by which power it was worked until 1863, when the increased traffic necessitated the employment of steam power for that purpose. The line was strengthened and improved, diminutive locomotives were constructed expressly for it, and since 1865 passenger carriages have been attached to each train. The difference in level between the two termini is 700 feet, and the average gradient is 1 in 92. The steepest gradient on the portion now used for passengers is 1 in 79·82, and the steepest on which locomotive engines are employed, 1 in 60. Some of the curves are exceedingly sharp, having radii varying from 2 chains to 4 chains. As the line is a continuous incline from Portmadoc to Festiniog, the locomotive is employed only to draw the trains in one direction; it then returns by itself, and the loaded trains run by gravitation down to Portmadoc—their speed being regulated by breaks. The original capital of the company was 36,000*l.* Since that outlay was incurred the line has been almost reconstructed; workshops have been erected and rolling stock manufactured out of revenue, bringing up the total cost of the line to about 86,000*l.* The net profits have amounted to upwards of 30 per cent. on the original capital, and they exceed 12½ per cent. on the total outlay of the undertaking.

New Tunnel under the Thames.—The past quarter has witnessed the completion of a tunnel under the river Thames between Tower Hill and Vine Street, Tooley Street. The noticeable feature of this work is the extreme rapidity, and comparatively trifling cost at which it has been constructed, the time occupied being only one year, and the total expense less than 20,000*l.*, whereas the old Thames Tunnel occupied eighteen years in construction, and cost over half-a-million sterling. This new tunnel consists of a circular driftway, 7 feet 3 inches in diameter, having an inclination from either side towards the centre of the river of 1 in 30. It is approached on each bank by a perpendicular shaft, that on the Middlesex side being 56 feet deep, and that on the Surrey side 52 feet. The lift at either end consists of an iron chamber, to the roof of which a chain is attached, which passes over a pulley at the head of the shaft, and at the other end is fixed to a balance weight, capable of adjustment according to the number of passengers in the lift. The bottom of each shaft communicates with a waiting-room, having seats along the sides. Along the tunnel is laid a railway of 2 feet 6 inches gauge, on which a small omnibus runs, capable of accommodating fourteen passengers at one time. Under the level of the tunnel at the bottom of each shaft there is an engine-room containing a 4-horse power engine for raising and lowering the lifts, and that on the Surrey side is also employed for hauling the omnibus, which is driven by means of an endless steel cord passing round a vertical pulley-wheel at the Surrey end of the tunnel, and a horizontal pulley-wheel placed between the rails at the Middlesex end.

PROCEEDINGS OF SOCIETIES.

Institution of Civil Engineers.—The session of 1870 was inaugurated on the 11th January by an address from the newly-elected President, Mr. Charles Blacker Vignoles, F.R.S. It would be impossible briefly to summarize Mr. Vignoles' speech, which for interest and importance has never been surpassed, and rarely equalled. In reading over this important paper, it appears that no branch of the profession has escaped notice from the time when "in the earlier stages of the human race their first want must have been, as it is now, a supply of water for men and beasts of tribes, whether nomadic or stationary, when no longer within reach of the natural streams or springs; and assuredly," said Mr. Vignoles, "the individual who first dug a well in the desert, and raised water to the surface, by the simple contrivance of pole and bucket, was the first mechanic—the first pre-historic engineer, whose rude invention has nevertheless been followed in all subsequent ages," down to the completion of the Suez Canal, "by cutting across the sandy ligament which has hitherto united Asia and Africa, by which a water communication has been opened, which will never again be closed so long as mercantile prosperity lasts or civilization exists."

"On the Statistics of Railway Expenditure and Income, and their Bearing on Future Railway Policy and Management." A paper on this subject was read before the Institution on 1st February last, by Mr. John Thornhill Harrison. After referring to the income from passengers and goods on the principal lines in the kingdom, the question of the further extension of railways was considered, and it was urged that many lines might be constructed at a cost of from 3000*l.* to 5000*l.* per mile, provided the landowners would sell their land for the purpose at the ordinary market value; that the Board of Trade would allow level crossings, and that gradients as steep as 1 in 20 or 1 in 30 were adopted. The subject of expenditure for working the line was next dwelt upon in some detail, and the percentage of net revenue on the total capital expended. Two large funds for investment of capital were also considered: the National Debt, which amounted to 750 millions sterling, and gave a return of 26½ millions per annum, or 3½ per cent., which was a burden on the industry and capital of the country; and the capital expended on railways, which amounted to 500 millions sterling, giving a return of 20 millions, or 4 per cent. per annum; whilst a sum nearly equal to the interest on the National Debt was annually expended in labour and materials.

Society of Engineers.—On 7th February Mr. William Adams, the newly-elected President, inaugurated the session of 1870–71 by an address. After reviewing the progress of the Society, and adverting to the several papers read during the preceding session, he proceeded to make some remarks upon locomotive engineering and the rolling stock of railways, detailing the several improvements that have of late years been introduced, and especially with reference to the application of break-power for bringing trains to a standstill, the two most important improvements for that purpose being the steam-break of M. Le Chatelier, and the friction-wheel break of Mr. John Clark.

South Wales Institute of Engineers.—An important paper has recently been read by Mr. Brogden, before the South Wales Institute of Engineers, "On the Comparative Merits of Large and Small Trams or Wagons for Colliery use." In the course of the discussion that followed it transpired that at a colliery in the Aberdare Valley there had been effected by the introduction of small trams a saving of 1*s.* 3*d.* per ton. In getting out 150 tons a day with a large tram fourteen horses were employed at a cost of 4*l.* 12*s.* 8*d.*, whilst with small trams the same amount of work was done for 1*l.* 11*s.* 8*d.*, showing a saving of nearly 6*d.* a ton on that item alone; besides which there was a difference in the price of driving headways, in the cost of rails, sleepers, &c. By the use of small trams there was also a considerable saving in the men called "dusters," and by reducing the headway a saving in "gobbers."

Men, it was also said, could earn more by the use of the small tram, which is therefore advantageous to them as well as to the masters.

Civil and Mechanical Engineers' Society.—On 8th December last Mr. R. M. Bancroft read a paper before this Society "On the Renewal of King's Cross Station Roof." When this station was opened in 1852 its roof created some little sensation, as it was the largest span-roof of the laminated type constructed in this country. After a period of eighteen years' existence it was found that the timber which formed the ribs was in a state of rapid decay, and it became necessary to replace them with something more durable. The wrought-iron main ribs were formed and accurately curved so as to fit in exactly between the old cast-iron shoes built in the walls on each side, the cast-iron spandril fillings of the old roof being cut shorter to suit the new wrought-iron ribs. The scaffold for the construction of the roof was designed so as not to interfere with the traffic constantly passing beneath it, and the large wrought-iron plate-girders forming it were constructed of such section that they might hereafter be used in bridges down the line.

Institution of Engineers in Scotland.—Professor W. J. Macquorn Rankine read a very interesting paper before this Society, upon being called upon to fill the presidential chair until the next election. This paper partook of the nature of a presidential address, and consisted of a review of the present state of engineering *progress* in its various and numerous branches; but it is on the subject of "Engineering Education" that Professor Rankine's paper dwelt with most force. In alluding to common errors under existing systems of education, the Professor stated: "One is led to expect results from the scientific branch of education which it is not really capable of accomplishing. The purely practical parts of engineering, such as the use of tools and the superintendence of works, cannot be soundly and thoroughly learned except through experience in real business; and it is a mistake to endeavour to teach them during a university course. The true laboratory for students of engineering science is to be found in the workshops of such cities as Glasgow, and amongst the earthwork, masonry, carpentry, and ironwork of engineering structures in progress."

Institution of Mechanical Engineers.—At the anniversary meeting of this Institution on the 27th January last, a paper "On Le Chatelier's Plan of using Counter-pressure Steam as a Brake in Locomotive Engines," by Mr. C. W. Siemens, came under discussion; and a paper was read by Mr. C. Cochrane, of Dudley, "On the further Economy of Fuel in Blast Furnaces, derivable from the High Temperature of Blast obtained with Cowper's Improved Regenerative Stoves at Ormesby, and from increased Capacity of Furnace, &c." M. Le Chatelier's plan for counter-pressure working consists in introducing a small jet of hot water from the boiler into the base of the blast-pipe or the exhaust part of the cylinder: this jet being discharged at boiler pressure into the atmospheric pressure of the exhaust passages, the greater portion of the water instantly flashes into steam at atmospheric pressure, and instead of the heated gases from the smoke-box, a moist vapour or fog is now drawn into the cylinder behind the piston, upon the engine being reversed.

LITERATURE.

"Our Iron-clad Ships; their Qualities, Performances, and Cost; with Chapters on Turret Ships, Iron-clad Rams, &c." By E. J. Reed, C.B., Chief Constructor of the Navy, &c.* Space will not admit of such a review here as this work deserves. The fact of its coming from the pen of one so experienced in the subject will at once commend it as an authority upon the matter of which it treats. Its title will convey a fair idea of the contents of the 320 pages of which this book consists; and we can only here state that whilst this treatise on Iron-clad Ships evinces a masterly knowledge of the subject on the part of its author, the style in which it is written is perfect, approaching at times to eloquence.

7. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society and Notices of recent Geological Works.)

Monographs of the Palæontographical Society, Vol. XXIII.—The success attending combined efforts was never more happily illustrated than in the case of the Palæontographical Society, which was formed twenty-three years ago for the purpose of describing and figuring British Fossils. It has published the works of twenty-six palæontologists, embracing in their monographs every division of the animal kingdom found fossil in this country. Nor is it merely the letter-press descriptions of fossils which it effects (though these now amount to 6405 pages 4to), but it is the superior means of illustration it furnishes which gives such value to the volumes of this Society. The plates now number 1006, and contain 18,991 figures. The volume before us contains 43 plates, some of which are double size. These plates, with descriptive text, are distributed to subscribers for 1*l*. 1*s*. per annum.

The volumes of the Palæontographical always contain a diverse series of monographs; thus we have in this year's issue,—Fossil

---

* John Murray. London: 1869.

Corals, Cretaceous Echinoderms, Oxford Clay Belemnites, Old Red Sandstone Fishes, Lias Pterodactyles, and Crag Cetacea. Such a "bill of fare" was never before presented at so modest a price.

Dr. Duncan's part contains six species of Corals from the Greensand of Haldon, thirteen species from the Gault, and six from the Lower Greensand. To this part is appended a complete list of British Cretaceous Corals, fifty-eight in all.

Dr. Duncan remarks, "The Coral-fauna of the British area was by no means well-developed or rich in genera during the long period in which the Cretaceous sediments were being deposited. The Coral tracts of the early part of the period were on the areas now occupied by the Alpine Neocomian strata, and those of the middle portion of the period were where the Lower Chalk is developed at Gosau, Uchaux, and Martigues."

"There are no traces of any Coral-reefs or atolls in the British Cretaceous area, and its corals were of a kind whose representatives for the most part live at a depth of from 5 to 600 fathoms."*

In Professor Phillips's monograph on the Oxford Clay Belemnites, the author notices a singular hiatus between the Inferior Oolite and the Oxfordian stage. It must, however, be borne in mind that pelagic and freely-wandering animals (such as the *Belemnitidæ* must have been, judging from their modern representatives, the Squids, Calamaries, and Cuttle-fishes) form a less sure basis for generalization than do the Brachiopoda and other sedentary forms of *Mollusca* and the Corals.

Free swimming Cephalopoda might forsake a large area for ages, if conditions were unfavourable, returning again at a later epoch, and again becoming plentiful as fossil remains in the mud of the period.

It is interesting to observe that Professor Phillips, who is perhaps the most careful observer living, and the last man to be carried away by an idea, has adopted the doctrine of descent with modifications, as may be gathered from the following extract;† speaking of *Belemnites explanatus*, sp. nov., from the Kimmeridge Clay, Professor Phillips observes, "On many accounts this form of Belemnite is of interest in the study of the series to which it belongs. On the one hand its resemblance to the older type of *B. abbreviatus* (*excentricus*) of the Oxford Clay and Oolite, and on the other to that of Speeton, in Yorkshire (*B. lateralis*), is such as to offer a most instructive example for study, in relation to the derivation of successive specific forms by hereditary transmission with modification."

Some interesting modern types of Loricarian fishes illustrate Mr. Ray Lankester's monograph on the *Cephalaspidæ* of the Old Red Sandstone.

---

* P. 46.

† P. 128.

These curious buckler-headed fishes are certainly among the most interesting as they are undoubtedly the very earliest forms of the vertebrate type with which we are acquainted.

One head-shield figured measures more than 6 inches across and above 7 inches in length.

Mr. Fielding has most successfully rendered the fine and delicate striæ on the plates of *Pteraspis* in plates vi. and vii. The histology of these fish-plates is carefully worked out and most beautifully illustrated by Tuffen West.

Professor Owen's monograph on the Lias *Pterosauria* deserves more than a passing notice.

For the first time we see before us an entire British Pterodactyle in his *Dimorphodon macronyx*, not restored at random, but carefully put together bone by bone from the three specimens in the British Museum. *Dimorphodon*, as we thus know it, has a long and slender tail firmly set and imbedded in ossified tendons, rendering it apparently an inflexible rudder; the hind limbs are well developed, as also are the claws and the wing-fingers. The head is very large, with beautiful contrivances for lightening it by means of large vacuities; the jaws are armed with larger laniary teeth, and rows of more regular minute and pointed teeth. There is no evidence that this species had a beak or horny termination to its jaws as Von Meyer believes to have been the case in *Rhamphorhynchus* from the Solenhofen beds.

Upon the affinities of the *Pterosauria* Professor Owen is at issue with Professor Huxley, the former arguing against their Ornithic and in favour of their Reptilian affinities, the latter placing them in the same group with the *Dinosauria*, the *Crocodilia*, and the *Anomodontia* (called by Professor Huxley the *Ornithoscelida*), the most bird-like of the Reptilia.

Professor Owen argues that the possession of feathers and warm blood are essentially bird-like attributes, whilst the absence of feathers in the *Pterosauria* proves them to have been cold-blooded reptiles. The Cockchafer is cited by Professor Owen to prove that powerful flight may co-exist with cold blood; but if we could compare the bulk of the insect with that of the Pterodactyle, there seems little doubt that the temperature would also increase with the size of the animal, and in proportion to the increased muscular work required to be accomplished.

We deprecate the tone adopted by the author in his critical review of Professor Huxley's observations,* and earnestly hope it may not be found in any future monographs.

The concluding Monograph, also by Professor Owen, treats of the Cetacean remains, occurring in the Red Crag, belonging to the genus *Ziphius* of Cuvier. These curious rostra are found in tolerable abundance in the Coprolite-workings in the Red Crag of Suffolk, and are usually much water-worn and eroded, as if the bed in which they were originally deposited had undergone subsequent denudation on some later Tertiary sea-beach. They often appear to have been bored into by *Pholades*.

---

* P. 74.

Twenty-three articles appear in the last three numbers of the 'Geological Magazine.' Of these the most important are: "On the Sequence of the Glacial Beds," by Searles V. Wood, jun.; "On Lithodomous Perforations," by J. Rofe, F.G.S.; "The Millstone Grit of the North Wales Border," by D. C. Davies; "The Character of Lavas," by G. Poulett Scrope, F.R.S.; "On Faults in Strata," by W. T. Blanford and by G. H. Kinahan; "New Zealand Plesiosaurs," by Professor Owen; "Boulder-Clay," by Mr. James Geikie; "Banded and Brecciated Concretions," by Dr. Ruskin. If Mr. Searles Wood, jun., can only induce the Geological Survey to adopt his classification for the later deposits of our island, much of our misery and uncertainty about the Contorted Drift and Boulder-Clay ends, and we may find a place for every pebble-bed and drift-deposit which we meet with, and can colour it at once.

But the Geological Survey are not converted, although they will, doubtless, gladly adopt much of Mr. S. V. Wood, jun.'s, admirable work on East Anglian surface-geology, when they come to Norfolk, Suffolk, and Essex.

Mr. Scrope continues his favourite theme, the character of Lavas. We hear, by-the-by, that he is arranging with Mr. Archibald Geikie a descent upon the Lipari Islands and Stromboli this summer, so we may look for a new view of modern volcanoes from a leading man of the day in Geology.

PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF LONDON.

The present number of the 'Quarterly Journal' of this Society deals in Australian Geology and Palæontology. On Dinosaurian Reptiles and their affinity with Birds. The evidence afforded by corals as to the physical geography of Western Europe in Secondary and Tertiary times. The Brachiopoda of the Budleigh-Salterton pebble-bed. A comparison of the Boulder-clay of the North of England with that of the South. On the Graphite of the Laurentian of Canada. On the Geology of the country around the Gulf of Cambay. On the Rodents of the Somersetshire Caves.

With rocks of Secondary age in Australia we have been hitherto unacquainted, and there seemed good reason to believe that this remarkable country held its head above water through the Mesozoic period.

Mr. Charles Moore has, however, brought before us evidence of the occurrence of fossils in erratic blocks from Western Australia, from the centre of the Continent, on Stuart's route, and from Queensland. These remains, although fragmentary, suffice to indicate fossils of Liassic, Oolitic, and Neocomian age.

The propriety, however, of applying the European palæontological standard to the geology of the Antipodes is exceedingly doubtful, and we are more than ever impressed with the value of the late Edward Forbes's observation, that the occurrence of similar fossils in formations of widely-separated continents was rather a proof of the diversity of their age than of their synchronous character. That marine faunas extend over a far wider geographical area than land animals must be admitted, but Mr. Seeley's observation, that natural groups of corresponding value exist in different areas of the globe, deserves consideration.

Professor Huxley contributes three papers, all bearing upon the Dinosauria and their affinity with Birds.

The skeleton of a young Iguanodon from the Wealden of the Isle of Wight (described long since by Professor Owen) proves, upon further examination, to be a new genus of Herbivorous Dinosaur (*Hypsilophodon Foxii*), and assists largely to increase the evidence in favour of the affinity between Dinosaurian Reptiles and Birds. A head of *Hypsilophodon* (obtained by the Rev. W. Fox), and referred to the same species, seems to have had its præmaxillaries produced downwards and forwards into a short edentulous beak-like process, the outer surface of which is rugose and pitted. The peculiar form of the lower jaw of Iguanodon would seem to indicate that its emargination was destined to receive this beak-like process of the præmaxillaries. The pelvic bones are singularly avian in their structure.

Professor Huxley reviews in his second paper the evidence already cited by himself and others (especially by Professor E. D. Cope, of Philadelphia), in favour of the ornithic affinities presented by the Dinosauria, and discusses at length the recently ascertained facts which bear upon this question. He compared the different elements of the pelvic arch and hind limbs in the Crocodile, the Dinosaur, and the Emu, and maintained that the structure of the pelvic bones (especially the form and position of the ischium and pubis), the relation between the distal end of the tibia and the astragalus (which is perfectly ornithic), and the strong enemial crest of the tibia, &c., furnish additional and important evidence of the affinities between the Dinosauria and Birds.

In Professor Huxley's third paper he referred to the bibliography of the Dinosauria, which, as a distinct group, were first recognized by Hermann von Meyer in 1830. He then indicated the families, into which he proposed to divide the group, *viz.*:—

1. The *Megalosauridæ*, with the genera *Teratosaurus*, *Palæo-*

saurus, *Megalosaurus*, *Poikilopleuron*, *Lælaps*, and probably *Euskelosaurus*.

2. The *Scelidosauridæ*, with the genera *Thecodontosaurus*, *Hylæosaurus*, *Pholacanthus*, and *Acanthopholis*. (The omission of *Scelidosaurus* is of course accidental, as the family is founded on that genus.)

3. The *Iguanodontidæ*, with the genera *Cetiosaurus*, *Iguanodon*, *Hypsilophodon*, *Hadrosaurus*, and probably *Stenopelys*.

Although *Compsognathus* had many points of affinity with the *Dinosauria*, as in the ornithic character of its hind limbs, yet it differed from them in several important particulars. Professor Huxley therefore makes a separate group for it, the *Compsognatha* forming, with the *Dinosauria*, an order, the *Ornithoscelida*.

After treating of the *Ornithoscelida* in relation to other reptiles, he concludes to place them in that great division of the Reptilia which he calls *Suchospondylia*, in which the thoracic vertebræ have distinct capitular and tubercular processes. The Suchospondylia embraces the *Crocodilia*, the *Dicynodontia*, the *Pterosauria*, and the *Ornithoscelida*.

With regard to the relation of the *Ornithoscelida* to birds, Professor Huxley stated that he knew of no character by which the structure of birds, as a class, differs from that of reptiles, which is not foreshadowed in the *Ornithoscelida*.

Dr. Duncan's paper "On the Geography of Western Europe during the Mesozoic and Cainozoic periods," elucidated by their Coral-faunas, would seem to have been intended to create a discussion for the purpose of bringing out the younger Agassiz, who is over for a visit in Europe. Considerable misconception exists in the minds of even advanced naturalists, as to the species of corals peculiar to the deep sea, as contrasted with the reef, lagoon, and shallow-water species. Dr. Duncan contrasted the fauna existing in our seas with the extinct coral-fauna of the Secondary and Tertiary epochs, and pointed out that a correspondence of physical conditions in the deposition of certain strata was marked by the presence of similar organic remains; thus the presence of compound cœnenchymal species of coral indicated reefs, and their absence in places where simple or non-cœnenchymal Madreporaria are found, is characteristic of deep-sea areas remote from land.

Professor Alexander Agassiz thought the depth at which true reef-building corals are said to exist would be considerably extended. A reef is in the course of formation at the present time off the coast of Florida.

Mr. Davidson has determined nearly forty species of Brachiopoda from the pebble-bed at Budleigh-Salterton, near Exmouth, Devon, and has figured them with his usual accuracy and artistic skill in three beautiful plates. It is to be feared that, with certain palæontologists, a difference in horizon is sufficient to constitute a difference in species; hence the zones of Ammonites, each marked by a different species, which is said *never* to occur above or below a certain narrow bed or horizon.

Professor Huxley would like to see the rise of a new race of palæontologists, relying simply on zoological characteristics, and not upon geological position. A considerable reduction in the number of species would, he thinks, undoubtedly result.

Although the term species is too often used where *variety* would be more appropriate, yet these distinctions—when kept within due bounds—have been found of great value in tracing out, by their characteristic fossils, the horizon of beds over widely-extended areas.

Mr. Searles V. Wood, jun., continues his researches on the Boulder-drift. He finds the Yorkshire Glacial clays are of two kinds; the lower containing chalk-debris abundantly, the upper containing chalk sparingly in its lower part, and gradually losing it upwards. The Boulders of Shap Fell Granite only occur in the Boulder-clay, without chalk. Mr. Wood ascribes their dispersion to the agency of floating ice during the submergence of the district.

The great chalky clay derived its chalk from the extrusion of a great sheet of land-ice over the sea, the chalk-mud being due to the abrading action of the ice.

The anniversary of the Geological Society of London was held on the 18th February, when the President announced that the Wollaston Gold Medal had been awarded to M. Deshayes, as an expression of the estimation in which his services to Palæontology and Geology (especially in regard to the classification of the Tertiary formation and its Molluscan fauna) are held by geologists of this country.

The balance of the Wollaston Donation-fund was presented to M. Marie Rouault, of the Geological Museum of Rennes, in aid of his researches upon the palæontology of the Devonian and Silurian rocks of Brittany.

Neither of the gentlemen was present, but both sent letters of thanks.

8. METEOROLOGY.

The subject which has secured to itself the most important papers published lately has been the wind-systems of the globe, a question which had been left at comparative rest for some time.

Mr. Buchan's paper "On the Mean Pressure of the Atmosphere, and the prevailing Winds over the Globe," appears in vol. xxv. of the 'Transactions of the Royal Society of Edinburgh,' and has been most carefully worked out. The mean monthly conditions of atmospherical pressure at the sea level are first discussed, on the basis of all trustworthy observations which were accessible, and then the prevailing winds are similarly treated, but with reference only to direction, not to force. The results obtained are entered on charts for each month and for the year. The broad facts arrived at are that the wind flows in accordance with Buys Ballot's Law around the areas of barometrical depression and elevation, the motion being retrograde in the first case, direct in the other, and that it does *not* flow as a constant anti-trade at the earth's surface in high latitudes, as supposed by Maury. The position of the respective areas of barometrical disturbance varies very considerably from month to month, and is mainly determined by the thermal conditions of the globe at the respective seasons.

It will be seen that the ideas of Mr. Buchan are somewhat at variance with Dove's theory of the paramount importance of the Polar and Equatorial currents (as N.E. and S.W. winds) in regulating climates. He has, however, submitted this theory to a special test, as on calculating the directions of the prevailing winds at each station he finds that almost always there are *two* maximum directions shown, but that in only 30 per cent. of the stations do these directions belong to either of the above-named winds; so that it cannot be maintained that there is a general flow of the winds of the North Temperate Zone towards and from the Polar regions.

In the theoretical explanation of air-motion, given by Mr. Buchan, the chain of reasoning is not perfectly conclusive. He argues in this way: if motion in the lower strata of the atmosphere be in a definite direction, a compensating movement must exist at an upper level. The lower currents are determined by the course of the isobaric lines, therefore the upper currents may be inferred from these same lines "taken reversely together with the isothermal lines taken directly." He assumes that if, over any area, temperature near the ground be low, it must necessarily follow that pressure at a great height over the same area must be much reduced. This may perhaps be true, but it is far from being as yet proved, in the utter absence of the possibility of any experimental confirmation of the statement, as we know nothing of the vertical distribution of pressure.

Taking the paper as a whole, it is one of the most valuable contributions to the science which has appeared of late years, and the least that can be said of it is that the results are fully commensurate with the labour bestowed on the discussion.

The other paper to which we have referred is one by Dr. Julius Hann, "On the Winds of the Northern Hemisphere and their Influence on Climate," read before the Vienna Academy. In the first part of this discussion the wind-systems are explained on the hypothesis of Dove's two currents; the Equatorial, flowing over the sea; and the Polar over the land: but the variations in their respective directions from true S.W. and N.E. are explained by the relations of pressure. That these variations do exist is shown by the fact that in the great continent, the coldest point of the windrose shifts through 108°, from N. 62° E. over the North Sea, to W. 44° N. in Eastern Asia. The warmest point shifts similarly through 61°. Corresponding changes are noticeable in the baric windrose, so that, as Buchan shows, the main directions of the wind are not S.W. and N.E. As to the effect on rain, it is found that the sea winds are always the rain bringers, and the land winds the contrary. Our driest wind is N.E. ; that for Pekin as well as for Toronto is N.W. Part II. is a special application of the results contained in the tables to the peculiarities of climate of the respective stations.

The quarter has on the whole been rather barren of meteorological papers both here and on the Continent, but this deficiency has been more than supplied by some works of a general nature. Mr. Keith Johnston, jun., has just brought out a 'Handbook of Physical Geography,' as a companion to the 'Physical Atlas.' The chapters, three in number, relating to Meteorology are very compact and comprehensive. Much of what he says on winds has been adapted from Mr. Buchan's paper just noticed; but as regards climate, the account of the Range Lines is a reproduction of a very good paper by the author, which appears in vol. vi. of the 'Proceedings of the Royal Society of Edinburgh.' In this paper he has discussed the range of temperature from January to July all over the globe. This map is an entirely new idea, and a most useful one, as in the question of Range all the differences between insular and continental climates are involved. Thus in these islands the range is about 20°. At Yakutsk it is 106°. No part of the open ocean has a range above 40°, while the curves above 60° are confined to the great continents.

On the whole, Mr. Johnston finds, as a practical result, that in the Temperate Zone the West coasts of continents have 15° less range than the East coasts, and a similar contrast is noticed between the opposite coasts of inland seas and lakes. Thus the coasts of the Mediterranean, which *face* East, have 10° more range than those which *face* West. The same fact is noticed on the shores of Lake Superior.

Dove has at last published Part II. of his 'Klimatologische Beiträge,' twelve years after its predecessor. In this he furnishes the text and tables to the 'Atlas of Monthly and Yearly Isotherms,' which appeared in 1864. The first fifty pages are devoted to a brief discussion of the climate of Western Europe, which is very interesting, but hardly worthy of the author's reputation. If we test it by what he says of these islands, it is evident that the sources of information are old and not quite accurate, while the statements themselves bear signs of haste and carelessness. Thus we are told that the hemispherical cup anemometer was invented by Osler, and improved by Dr. Robinson. Dove assumes that observations in London, Liverpool, and Dublin, represent our climate fairly, while the instances cited to prove the mildness of our climate fall far below the real facts of the case, especially in the vegetable world. This paper is followed by some remarks on the climate of the Polar regions, but the bulk of the work is taken up with Temperature Tables. These are most valuable, containing, as they do, for about 1200 stations the yearly, monthly, and seasonal means, with the extreme range of climate, as well as that from summer to winter. To these tables are appended others of the non-periodic variations, giving for more than 400 places the monthly means derived from several years' observation, and the deviations from those means observed in every year from 1856 to 1868. Remarks on the average and absolute variability of temperature follow, and the volume is concluded with a notice of some of the most remarkable exceptional seasons which have been recorded, such as severe winters, *e.g.* 1838, 1850, both of which, though cold in Europe, were warm in America; famous vintages, *e.g.* the Comet Year, 1811, and various other notabilia as regards climate. Many of these particulars have been already described by Dove in his 'Five-day Means of Temperature,' and in his papers read before the Berlin Academy; but the thanks of all meteorologists are due to him for having condensed such a mass of information into a work of 300 pages.

Professor Wild has followed up the publication of the 'Annales' for 1865 for the Russian stations by the announcement of the issue of a new serial, 'Repertorium für Meteorologie.' Formerly, a periodical under this title was published by the Geographical Society, at the suggestion of Kämtz, who was himself the author of most of the papers in it. The new 'Repertorium' is to appear under the auspices of the Academy, and to contain special discussions of the observations which are given in full in the 'Annales,' as well as independent papers on the Meteorology of Russia. The first part has already come out, and we find in it the instructions for the reorganization of the meteorological stations throughout Russia, with the tables for the reduction of observations on the basis of centigrade and metrical scales, which are to be substituted for the former tables drawn up by Kupffer. There is also an 'Essay on the Wind and Rain of Taurida and the Crimea,' by W. Koeppen. It is impossible to do more than allude to this paper, which is of the greatest value, being a discussion of a large accumulation of trustworthy observations.

It is curious that at the very time that Sir E. Sabine was discussing the climate of Barnaoul and Nertschinsk, as described in our last number, Lieutenant Rikatcheff was investigating the same subject, and he has published his results in a paper "On the Diurnal

March of Temperature" at the two stations in question, deduced from a series of twenty years' hourly observations. This paper forms part of No. II. of the 'Repertorium.' The results on the whole agree very well with Sir E. Sabine's. The climate of Nertschinsk is more truly continental than that of Barnaoul, but this difference is not exhibited to its fullest extent, owing to the difference in elevation between the two stations, the former being situated 2200 feet above the sea, as compared with 400 feet, the elevation of the latter.

The second report of the 'Norddeutsche Seewarte,' that for the year 1869, has just appeared. The main points brought forward by Herr von Freeden in this report have a special reference to Sailing Directions and to the practical pecuniary value of the office to the shipowners and traders of Hamburg. Accordingly, hitherto he has not been able to devote his attention to the general subject of ocean meteorology. However, the North German Parliament has now adopted the office, and several of the seaport towns of Prussia, such as Memel and Dantzic, have affiliated themselves to it as branch stations for the issue of instruments and registers.

The Report also contains interesting information relating to the Telegraphic Intelligence of Storms, sent to Hamburg by the Meteorological Office in London. From this it appears that the storm only preceded the warning on four occasions, three of which were accounted for by the intervention of Sundays, and that no intelligence at all of two other storms was received, owing in one case to a break-down on the telegraph line. Accordingly it will be seen that the storms which are felt on the Elbe almost invariably pass over these Islands. The instances in which the weather at Hamburg was undisturbed, subsequent to a warning, are all proved to have been accounted for by the fact that the storm died out before crossing the North Sea.

In conclusion, we have to notice the very important changes as regards meteorology which are in progress in France. M. Leverrier has been superseded, and his successor at the 'Observatoire Impérial' is M. Charles Delaunay. It is understood that for the future meteorology will form no part of the duties of the astronomical staff, and we hope that ere long this special science will receive in France a development worthy of its daily increasing importance.

9. MINERALOGY.

FROM the days when Montezuma presented Cortez with four *Chalchihuitls,* on his landing at San Juan de Ulua, it has been matter of dispute among mineralogists what was the true nature of the ornamental stone designated by this Mexican name. That it was held in the highest esteem is well known from many passages in the old chroniclers. It appears to have been worn only by the chiefs, and on the death of a great dignitary a chalchihuitl was placed in the mouth of the corpse. Indeed, the name of the stone became synonymous with all that was most valued; and according to one tradition, Quetzalcoatl—the law-giver, priest, and instructor of the Mexicans—was begotten by one of these stones, which the goddess, Chimalma had placed in her bosom. In recently laying before the Lyceum of Natural History of New York a fine collection of carved chalchihuitls, Mr. Squier took occasion to bring forward a body of evidence tending to identify the stone.* Molina, in 1571, defines the word as signifying *esmeralda baja*—an inferior emerald. Sahagun describes it as "a jasper of very green colour, or a common emerald." Montolina, in 1555, in enumerating the riches of Mexico, after speaking of gold, silver, and all metals and stones, refers to the chalchihuitls, and concludes by saying, "Las finas de estas son esmeraldas." Professor Blake has sought to identify it with the turquoise, but the author considers this not to be the true stone of the Mexicans and Central Americans. "The weight of evidence, in my opinion," says Mr. Squier, "goes to show that the stone, properly called chalchihuitl, is that which Molina defines to be 'baja esmeralda,' or possibly nephrite, 'a jasper of very green colour,' as Sahagun, already quoted, avers."

Two Indian meteorites have been subjected to an exhaustive examination by Professor Nevil Story Maskelyne, the Keeper of the Collection of Minerals in the British Museum—a collection which vies with Vienna and Calcutta in the number and variety of its meteoric specimens. One of the stones fell at Busti, between Goruckpoor and Fyzabad, on the 2nd Dec., 1852; and the other fell at Manegaum, in Khandeish, on the 26th July, 1843.† The Busti meteorite consists for the most part of enstatite, a silicate of magnesia, in which are imbedded small spherules of *Oldhamite.* This mineral is composed mainly of sulphide of calcium; and the presence of such a compound would seem to indicate that the conditions under which the ingredients of the meteorite were formed must have been very different from those met with on the surface of our globe.

---

* 'Observations on the Chalchihuitl of Mexico and Central America.' By E. G. Squier, M.A. New York, 1869.

† 'Proceedings of the Royal Society,' Jan. 13, 1870, p. 146.

Not only does it bespeak the absence of water and of oxygen; but having regard to the conditions needful for the production of this particular compound, the author thinks himself justified in pointing to the presence of some reducing agent, which operated during the formation of the constituents of the stone—such an agent as would be furnished by Graham's meteoric hydrogen.

Oldhamite forms spherules of a chestnut-brown colour, having a specific gravity of 2·58, and presenting a cubic cleavage. In some of these spherules there are minute gold-coloured octohedral crystals, which contain calcium, sulphur, and a rare metal—probably titanium. As a befitting compliment to the gentleman who forwarded the Busti meteorite to this country, Maskelyne describes this second mineral under the name of *Osbornite.*

Dr. Giovanni Strüver's studies in Italian mineralogy have lately been directed to the examination of the iron-pyrites of Piedmont and of Elba.* In the collection of the Engineering School of Turin, and of the University Museum in the same city, nearly 6000 specimens of Italian pyrites are to be found. The author has thus had ample materials for study, and that he has made good use of his opportunities is clear from his exhaustive monograph on the subject. He describes the various simple forms and combinations in which the Italian mineral occurs, including many newly-observed forms. It is notable that in 5603 specimens only three distinct simple forms were found. The memoir is illustrated by a series of fourteen plates.

Some few years ago, Herr Stein described a mineral under the name of *Staffelite.* It had the extraordinary composition of a hydrous phosphate and carbonate of lime, with a fluoride of calcium and traces of iodine. It occurred usually as a greenish incrustation, but was said to be also found in rhombohedral crystals. A similar substance has been met with in certain phosphorite workings near Offheim, in Nassau; and upon this crust of so-called staffelite were some fine clear crystals of apatite. Dr. Kosmann publishes an analysis of this apatite,† and assigns to it the formula: $5\,(3\,\mathrm{Ca\,O.\,P\,O_5}) + 2\,\mathrm{Ca\,Fl}$. It is notable for containing as large a percentage as 4·52 of fluorine, and for the presence of magnesia. The author believes that staffelite is nothing more than an impure form of apatite rapidly deposited and contaminated with the salts of the mother-liquor from which it was evaporated. Dr. Kosmann also describes a new mineral under the name of *Lime Wavellite,* the composition of which is sufficiently indicated by its name.

In the Bergmannstroost mine at Altenberg in Silesia certain needle-like crystals are found penetrating brown-spar. Under the microscope they appear as strongly-striated rhombic prisms, with indistinct octohedral terminations. Formerly they were taken for antimony-glance, but when it was found that they contained lead, they were referred to either the species Jamesonite or Boulangerite. Dr. Websky has, however, recently shown that this mineral constitutes a new ore, which he proposes to designate as *Epiboulangerite.* It is a sulphide of antimony and lead, which may be thus formulated: $(S b_4, P b_6)\ S_{15}$.*

---

* 'Studii sulla Mineralogia Italiana. Pirite del Piemonte e dell' Elba.' Torino, 1869.

† 'Zeitschrift d. deutschen geolog. Gesellschaft,' Bd. xxi., Heft 4, p. 795.

Professor Wöhler announces the discovery of minute crystals of diamond, with the native platinum of the Oregon; and diamonds are also reported from Bohemia.†

Ramelsberg has been led to compare the relation of gadolinite with several other species, and finds that datolite, euclase, and gadolinite form an isomorphous group.‡

10. MINING AND METALLURGY.

Mining.

The mining interests of the country are promised rather more than the usual amount of attention from the British Legislature during the present sitting of Parliament.

The Secretary for the Home Department has introduced his "*Mines Regulation and Inspection Bill,*" which was read for the second time on the 21st of February.

Lord Kinnaird, on Thursday, the 17th of February, introduced a Bill to the House of Lords, which is an attempt to apply the "Mines Regulation Act of 1870" to the metalliferous mines of the country.

The President of the Poor Law Board has intimated his intention of bringing again, before the House of Commons, the consideration of the question of rating metalliferous mines for the support of the poor.

The Government Mines Regulation Bill, introduced by the Home Secretary, professes, in its broader features, to fix definitely the responsibility in connection with the workings of all collieries, to secure increased safety in the mine, and to promote the better education of the mining population.

Last year the Mining Association of Great Britain, and the Colliery Inspectors, representing the Home Secretary, agreed to the following provision:—"That in every coal and ironstone mine an amount of ventilation shall be constantly produced, adequate to dilute and render harmless noxious gases, to such an extent, that the working places of the pit's levels and workings, and the travelling roads to and from the working places, shall be in a fit state for working and passing therein, *but that no owner, agent, or other person shall be held to have contravened this regulation, unless it shall be shown that all reasonable precautions have not been taken.*" This saving clause has been altered in the present Bill to:—"Provided that no owner, agent, or other person shall be held to have acted in contravention of this regulation, if it is shown that all reasonable precautions have been taken by the owner, agent, or person who is so charged."

---

* 'Zeitschrift d. deutschen geolog. Gesellschaft,' Bd. xxi., Heft 4, p. 747.

† 'Comptes Rendus,' 24 Jan., 1870, p. 140.

‡ 'Zeitschr. d. d. geol. Gesell.,' Bd. xxi., Heft 4, p. 807.

This proposition is regarded as the turning-point of Mr. Bruce's Bill, and already loud is the cry amongst colliery owners and agents against it. "It cannot be supposed for a moment," says the 'Colliery Guardian,' "that they (the coal-owners) can take any other course than that of opposing it to the utmost, nor will they find any difficulty in showing that English legislation contains no precedent for an enactment which assumes that every person charged is guilty, and may be punished as such, unless he can prove himself innocent."

The question of *responsibility* is the one over which the battle will be fought. Every one is, of course, desirous of relieving himself from this burthen; and it is, indeed, a heavy one in some of our collieries, where the lives of hundreds of men are dependent entirely on the unceasing attention of a single mind. If the colliery owners and agents can relieve themselves of this by any pressure which they can bring upon our legislators, they will most certainly exert themselves to the utmost to secure the necessary force. We cannot ourselves see any alternative. The responsibility of securing the most perfect appliances, in every division of the workings of a colliery, must rest somewhere, and it cannot be allowed to be capable of being shifted from one individual to another. In every colliery some head-man must be made responsible, and the Bill does not appear unjust on this point, for if this responsible head can show, after an accident has occurred, that every proper precaution had been taken, he will be held to be guiltless of any blame.

The employment of women and children, the payment of wages, the special rules and provisions as to arbitration, are all carefully dealt with in this Bill. The clauses which relate to inspection do not appear to us to be entirely satisfactory. Much has been said of the inability of twelve inspectors to visit, within the year, the 3000 collieries in the United Kingdom. It does not appear to us to be desirable that they should do so, but an earnest and intelligent man may make himself perfectly familiar with his district, without subjecting himself to the labour, or the coal-owner to the annoyance, of prying into the details of the subterranean workings. Lord Elcho remarked,—"The name of 'Inspector' was a misnomer, for the inspectors did not profess to go into the mines, they merely held an inquiry when an accident had occurred. Accordingly they might with more truth be called '*Accident Inquirers.*'" We fear a good and sufficient reply cannot be given on this point to Lord Elcho. Mr. Bruce, anticipating, as he could well do, from the discussions of last year, on the same subject, attempted to answer this, but all that he said, cannot be regarded as other than ingenious special pleading.

Mr. Lancaster referred to many of the causes leading to our present imperfect system of working for coal. To these we can only direct attention. His concluding remarks are of too much value not to be quoted:—"While many of the managers of mines were men of first-class education, and also of great practical experience, it was necessary that the younger men should receive a technical as well as a practical training. He hoped that as to some of these questions, the Home Secretary would adopt a much bolder course than that which he had yet taken, and would not hesitate to carry out the full recommendations which had been made."

Lord Kinnaird's Bill provides for the establishment of General Rules and Special Rules for Metalliferous Mines as nearly similar as possible to those proposed for collieries. It is evident from this that the different conditions of the two systems of mining cannot be correctly understood by his Lordship. The Bill provides for the effective ventilation of the metal mines, the depositing of plans with the Secretary of State (there never has been any objection to furnishing plans, as the large collection already in the hands of the Government in the Mining Record Office proves), and for such arrangements as are thought to be conducive to the health of the miners.

"Our Future Coal Supply" has claimed the attention of the South Staffordshire and East Worcestershire Institute of Mining Engineers, Mr. Richard Latham and Mr. George Spruce contributing two papers containing much important matter relative to the future workings of the thick coal of Staffordshire, and the probable extension of the Staffordshire field towards the coal-field of Shropshire.

Mr. Walter Ness, of Pelsall, also read a paper "On part of the Coal-field of Fife, N.B.," in which he proved, probably beyond much doubt, a large extension of this coal-field beyond the present workings. From this he adventures farther from the shore, and says:—"If we take the total area of the Forth, where we have reason to believe those Coal-measures exist in their entirety, we have about 180 square miles in their entirety . . . and we get 12,672,000,000 tons. Taking the other parts of the nation (sea-bed ?) in like manner available, opposite Northumberland, Durham, and Yorkshire, and under the German Ocean, also opposite Ayrshire, Cumberland, Lancashire, and the Bristol Channel, on the west coast, as jointly capable of yielding a similar quantity of coal to that of the Firth of Forth, we shall then have 25,344,000.000." These are large figures—of their value we can only judge by the exactness of other statements made in this paper. "The investigation of the Royal Commission happily assures us that there is coal enough in store for several generations to come." Such is the opening paragraph of Mr. Walter Ness's paper. The fact being that the Royal Commission has not given one word of assurance in any form—and, we can state upon authority, that they are not yet in a position to do so.

METALLURGY.

There does not appear to be any novelty worthy of notice. The arrangements made upon the termination of one of the Bessemer Patents have led to considerable activity in the manufacture of Bessemer steel, and probably the result will be that, ere long, steel rails will almost entirely have superseded the iron ones, to which we have been so long accustomed.

A few interesting experiments are in progress, but none of the results yet obtained are sufficiently reliable to warrant our placing them on record.

11. PHYSICS.

LIGHT.—It is a well-known fact that M. Schroetter proved that the action of sunlight converts ordinary phosphorus into red amorphous phosphorus. Sulphur, according to M. Lallemand, is similarly affected by the direct action of sunlight, inasmuch as the sulphur previously soluble in sulphide of carbon, and crystallizable, is converted into an amorphous modification insoluble in sulphide of carbon. The author placed a concentrated solution of sulphur in sulphide of carbon in a sealed tube, and exposed that tube some time to the action of the sun's rays, concentrated by a lens; this causes a copious precipitation of sulphur as an amorphous insoluble matter.

Mr. Burt has examined the action of coloured light upon the *Mimosa pudica*. The plants are placed under glass jars constructed of variously-coloured glass. The chief fact observed in respect of these very sensitive plants is that by being covered with a green-coloured glass jar, the plant rapidly becomes insensible, and dies in a very short time.

The Rev. Father Secchi, after referring briefly to his former observations of the spectrum exhibited by Uranus, states that the spectrum of Neptune consists chiefly of three lines, or bands, placed near the green, and that its light is entirely devoid of red; this is confirmed by the colour exhibited by the planet when seen through a telescope, which is a sea-green.

M. Feil has exhibited before the French Academy samples of perfectly homogeneous heavy flint-glass for optical purposes free from any bubbles or defects, and in masses weighing from 25 to 35 kilos. The process whereby this is obtained is not explained; but the statement is made that the crucibles having been protected from the effects of the lead, a heavier glass even than Faraday's can be made. The maker sent also a set of samples of beautifully-made artificial precious stones, not mere specks, but of good size. The aluminates of lime, of baryta and lime, of lead and of bismuth, are proposed for flint-glass; and the aluminates of magnesia and the silicates of magnesia and alumina for crown-glass.

M. Bontemps, the managing director of the celebrated glass works at Choisy-le-Roi, has arrived at the following results in connection with the coloration of glass under the influence of direct sunlight:—Within three months after having been exposed to sunlight, the best and whitest glass made at St. Gobain is turned very distinctly yellow; extra white glass (of a peculiar mode of manufacture) has become even more yellow, and gradually assumes a colour known as *pelure d'oignon;* glass containing 5 per cent. of litharge was also affected, but far less perceptibly; crystal glass, made with carbonate of potassa (the other varieties referred to contain carbonate of soda), litharge and silica, was not at all affected; English plate-glass, made by the British Plate-Glass Company, and exhibiting a distinctly azure-blue tinge, remained also unaffected. The author attributes the coloration, which begins with yellow and gradually turns to violet, passing through red *pelure d'oignon,* to the oxidizing effects of the sun's rays upon the protoxides of iron and manganese contained in glass.

M. Schinz states that platinum brought to bright white heat by means of the ignition of a mixture of hydrogen and carbonic oxide gases, yields a light which, in relation to good coal-gas, is as 1·24 to 1·0.

Professor B. Silliman has examined, in a lengthy series of experiments, the relation between the intensity of light produced from the combustion of illuminating gas and the volume of gas consumed. His experiments prove, among other matters, this theorem—that the intensity of gas-flames (*i. e.* illuminating power) increases, within the ordinary limits of consumption, as the square of the volume of the gas consumed. The chief point of interest, for the consumer of gas, to be deduced from the data here presented is, that where it is important to obtain a maximum of economical effect from the consumption of a given volume of illuminating gas, this result is best obtained by the use of burners of ample flow.

HEAT.—According to MM. Troost and Hautefeuille, carbon when combining with oxygen, only gives out 8000 caloric units; boron, under the same conditions, yields 14,400 caloric units; while, when boron combines with three equivalents of chlorine, 104,000 caloric units represent the heat set free.

The heat disengaged by the combination of 1 grm. of amorphous silicium with oxygen is 7830 units, with chlorine 5030. When 1 grm. of chloride of silicium reacts upon 140 times its weight of water, it is 2915; the heat disengaged when 1 grm. of amorphous silicium is converted into crystallized silicium is 290 units of heat.

Dr. St. Claire-Deville states that the oxygen dissolved during the fusion of platinum causes this metal to present the same phenomenon as molten silver—*viz.* scintillation and spirting while in the molten state.

In a paper "On the Heat given off by the Moon's Rays," M. Zantedeschi states that, as far back as the years 1685 and 1781, the Italian *savants* Geminiano, Montanari and Paolo Frisi proved the existence of rays of heat emitted by the moon, by means of lenses and ordinary thermometers. The author refers to his observations made some twenty years ago, when he applied thermo-electric apparatus, as well as spirit thermometers and lenses, and obtained results fully confirming those made and recorded by the Italian *savants* just alluded to.

In Germany the doors of the steam-boiler furnaces are now very generally provided with square pieces of mica, properly fastened, by means of which the fireman is enabled to observe the fires without the necessity of opening the furnace-doors too frequently, which is injurious, on account of interfering with the draught and proper course of combustion of the fuel, by reason of the access of irregular currents of cold air. Mica withstands a very high temperature; and the accidental breakage of the squares of this substance is guarded against by a properly-constructed iron-wire guard outside.

Dr. Ziurek states that gas from the brown coal from Furstenwald, five miles from Berlin, will shortly be made on the spot, and collected in Berlin in twelve gas-holders, each of a capacity of 750,000 cubic feet. The gas will be carried, as usual, in underground mains, and chiefly applied for heating purposes. 3000 cubic feet of this gas have a heating power of one-third of a ton of best coals, and are equal to 1 ton of best Prussian brown coal. 1000 cubic feet of this gas will cost about 5*d.* in Berlin; and the equivalent value of the heating power of this gas as compared with a ton of coals will be 4*s.* 6*d.* The works have been made to supply 950,000,000 cubic feet of gas annually, or at the rate of $2\frac{2}{3}$ millions of cubic feet daily.

Electricity.—A thermo-electrical apparatus, with galena and iron, has been made by MM. Mure, Clamond, and Gaiffe. According to the results of their experiments, this apparatus deserves the attention of all who require galvanic batteries, since regularity and steadiness of action are here combined with economy and the absence of inconvenient vapours.

For telegraphic work or domestic purposes, where a constant galvanic current is required with little trouble (electric bells, fire and thief detectors), the writer has found the new battery known as the Leclanché cell to be most perfect in action. The main feature is that peroxide of manganese is used with zinc (not amalgamated) and an aqueous solution of an alkaline salt, chloride of ammonium being preferred. The cells are of three sizes: the smallest, with a porous pot 4·3 inches high, can accomplish an annual electric work which may be represented by 620 grains of copper reduced in the voltameter; the medium size, with a 6-inch porous pot, can reduce from 950 to 1000 grains; while the large size gives a work equal to 1500 or 2000 grains.

F. Zaliwski has described a galvanic element with three fluids. This contrivance consists of two porous cells placed one inside the other, and surrounded by another suitable vessel. The inner vessel contains nitric acid and a piece of carbon, the intermediate vessel contains sulphuric acid, and the outer vessel a solution of sal-ammoniac in water and a piece of zinc. This author states that this arrangement is superior to a Bunsen cell.

The phenomena of atmospheric electricity at the island of Haiti, or St. Domingo, as it is also called, are of a very striking character. According to Mr. Ackermann, who has during a series of five years made meteorological observations at Port-au-Prince, there have, on an average, been 129 days of each year either severe thunderstorms or other very marked electrical phenomena, especially during the months of May, July, August, and September. Severe thunderstorms more frequently occur during day than night-time. The year 1868 was especially remarkable for severe thunderstorms; during one of these, lasting for forty-five minutes, 400 lightning flashes were distinctly seen.

A company has been formed in America with the view of covering other metals, by galvano-plastic means, with a more or less thick coating of pure nickel. Since that metal is very hard, it resists, even in thin layers, rather rough usage; it is not oxidized, even in contact with water, at the ordinary temperature, and the metal assumes a brilliant polish if required. The method employed for the deposition of nickel was treated of at a meeting of the French Academy. The company alluded to have established a branch manufactory at Paris, under the management of M. Gaiffe.

M. Gaiffe calls attention to the fact that the presence of even the smallest quantity of potassa, or soda, or alkaline earths in the bath containing the nickelizing preparation is injurious to effect a properly-adhesive coating of the metal. The use of perfectly pure double chloride of nickel and ammonium, or of perfectly pure sulphate of nickel and ammonium, and, moreover, of pure nickel as one of the electrodes, is required. By these means the nickel is made to adhere regularly and strongly, and only requires polishing after the metal, coated over, is taken from the bath. On the other hand, M. Becquerel now states that he has purposely repeated some of his former experiments, with the express view of ascertaining whether the statement made by M. Gaiffe, concerning the injurious action of the presence of potassa, be correct or not. The result of experiments is that the presence of potassa is not at all injurious to, and in no wise affects, the deposition of nickel, since the double sulphate of nickel and potassa can be applied, as well as the double sulphate of nickel and ammonia; but if the positive electrode is not made of nickel, it is necessary to add free ammonia, in order to saturate the sulphuric acid, which is set free.

M. Scoutetten states that the accidental striking of lightning on the house of a vineyard proprietor caused the rupture of several large hogsheads containing wine, which found its way into a cavity existing in the cellar of the house. The owner imagined his wine lost and spoiled, but found, to his astonishment, that the wine, instead of having been deteriorated, had become better than it was before. This accidental occurrence having come to the knowledge of General Marey-Mouge, caused M. Scoutetten to be consulted, and a series of experiments instituted with various kinds of wine, of inferior as well as medium quality. A series of experiments, made on the large scale, and with various sources of electricity, led to the result that electricity, under whatever form applied (whether as a regular current, or a succession of discharges accompanied by sparks), improve wine, rendering it mellow and mature. As to the mode of action of this agent, the author thinks that the bitartrate of potassa present in wine is decomposed, the potassa set free saturates the acids of the wine, and the free tartaric acid, reacting upon the fatty matters present, favours the formation of the ethers which constitute the bouquet of the wine. Moreover a small quantity of water is decomposed, and the oxygen thereof reacts upon some of the constituents of the wine, thereby forming new compounds which are peculiar to old wines.

12. ZOOLOGY—ANIMAL PHYSIOLOGY AND MORPHOLOGY.

PHYSIOLOGY.

Researches on the Relation of Heat to Work in the Human Body.—Professor Pettenkoffer, of Munich, has undertaken an investigation into the amount of heat produced by the human body when at rest and when at work, which promises to give highly important results. The wonderful experimental chamber which King Max had constructed for Pettenkoffer's work is to be made use of. The chamber, which is about 10 feet square, is fitted with an iron tube through which the air is regularly drawn by means of an aspirator worked by a steam-engine, the air being accurately measured in a gas meter. Smaller aspirators bring measured quantities of the air through analysis-tubes in which the quantities of carbonic acid, water, hydrogen and carburetted hydrogens (the last two by combustion with spongy platinum) are determined in the air both before and after it enters the chamber. The small aspirators, bringing a small but constant fraction of the whole air passed into the chamber through the analysis apparatus, the quantities of carbonic acid gas, water and hydrogen in the whole can be readily calculated. It is now intended to take the temperature of the air before and after it traverses the chamber, and in this manner to ascertain the actual amount of heat produced by the human body when at rest and when at work, and in relation to the amounts of the various excretions. For this purpose a smaller chamber has been constructed within the first made, and arrangements adapted by means of non-conductors, &c., to prevent, as far as possible, the loss of heat. It is found that there is a constant loss of about 40 per cent. of the total heat with two candles burnt in the chamber; of about 50 per cent. with four. The heating effect upon the air passed through the apparatus is determined before each experiment with stearine candles of known weight, and thus when a man is placed in the chamber instead of the candles, you get his heating effect in terms of stearine candles, and this is, of course, at once convertible into units of heat. The preliminary experiments with candles promise very accurate and satisfactory results from this method. As an apparatus for chemical analysis the chamber is perfect; so perfect that the percentage composition of a candle can be determined as accurately by burning it in the chamber, and the fractional analysis, as by the most complete direct combustions. The determination of the heat produced is a matter of more difficulty on account of the fluctuations of external temperature and the delicacy of the thermometers which must be used; but Professor Pettenkoffer has used every precaution, and succeeded in rendering the apparatus efficient. The experiments are now in progress; a man is to be kept in the chamber for six to eight hours, and the work done is in the form of crank-turning.

The Absence of Currents in Uninjured Inactive Muscle.—Professor Hermann states that if the gastrocnemius muscle of the frog be so prepared for investigation that no contact between the cutaneous secretion and the surface of the muscle takes place, then, with an exceedingly delicate galvanometer, only the very smallest deflection of the needle is obtained. He concludes, therefore, that by still greater care muscles can be obtained perfectly free from currents, and regards previous observations of muscular currents as having a very different significance to what has been supposed, being really artificial phenomena due to certain accidents of manipulation.

Pasteur's Views on Fermentation.—Professor Liebig disputes Pasteur's theory that the decomposition of sugar in fermentation depends on the development and multiplication of yeast-cells, and that fermentation is only a phenomenon accompanying the vital processes of the yeast. Liebig considers that Pasteur's researches have not explained fermentation, but have only made known another phenomenon—the development of yeast—which equally requires explanation.

Physiology of Sepia.—A series of interesting experiments have been made by M. Bert on this subject. He finds that the excision of the large supra-œsophageal ganglion-mass causes no pain or inconvenience to the animal, but simply deprives it of *voluntary* motion. He hence infers it to be equivalent to the vertebrate cerebrum. The contents of the salivary glands, as also of the liver and pancreas (so-called), are acid. The peritoneal cœca excrete uric acid. Strychnia and curare have the same effect on this animal as on vertebrates.

MORPHOLOGY.

Commensalism.—Professor Van Beneden, in an interesting address to the Belgian Academy of Sciences, proposes this word to distinguish a group of animals hitherto confused with what he would term veritable parasites. Commensal parasites, or commensals, do not feed *on* the animal with which they are found, but *by* it: they are not destructive or injurious to their hosts, but often are of service, if we may judge from the constancy of association and the satisfaction which both parties seem to enjoy. Professor Van Beneden distinguishes fixed and free commensals. Among the fixed we may mention the various barnacles which are attached to whales and sea-turtles; the *Anemone parasitica*, which invariably is fixed to a shell inhabited by a particular species of Hermit-crab, said to exhibit great affection for the polyp it bears on its back; many Polyzoa and Hydrozoa, which attach themselves to the carapaces of crustacea, especially the hairy-looking *Dromia* of our southern coasts.

Free commensals are the most numerous. Little fish live *inside* jelly fishes, without incommoding their host, or being incommoded; a whole troop of a particular species may be thus sometimes seen. Similarly a fish called Fierasfer lives inside a Holothurian, and in a large species of Anemone the same observation has been made. Dr. Semper has described, in addition to the little fish inhabiting Holothuriæ, several molluscs, which also live in this way; whilst Müller made known *Entoconchon*, from the *Synapta;* and *Stylifer* lives on *Echinus*. The Remora is a remarkable instance of commensalism. This strange fish, by means of the sucker on the back of its head, attaches itself to other fish and to whales, sometimes to ships, and is thus carried along through rich feeding-grounds. The inhabitants of Mozambique use this fish as a means of capturing others, tying a string to it and letting it out into the sea, when it attaches itself to some unsuspecting inhabitant of the ocean, which, together with the Remora, is speedily dragged to shore. The little crustacean (*Pinnotheres*), which lives inside the shell of the common edible mussel, has long been known, and various species in this and other countries have excited speculation and fable. There is no doubt a most cordial understanding between the little crab and its host; and though we cannot go so far as to believe that the crustacean acts as a watchman for the Mytilus, warning it when to close its shell, it is yet very evident that there is a close relationship of reciprocal advantage existing between the two. *Chætogaster*, the little worm which crawls about on *Lymnæus* and *Planorbis*—the common water-snails of our ponds—is a good example of a commensal, sticking very close to his friend, feeding on the *Cercariæ* (*true* parasites) and other matters which accumulate on the snail's body. Many tubicolous Annelids have a commensal, or messmate, who shares their residence; such are many scale-bearing Annelids—the Polynöina, which ensconce themselves in the tubes of *Chætopterus insignis*, of *Terebella nebulosa*, and others. One Polynöe was many years since described by Professor Huxley as living on the common Cross-star, and hence named *P. astericola*.

The distinction between *commensal* and *parasite* is this, that the parasite uses his host for food; whilst the animals which are mentioned above, and many others enumerated by Professor Van Beneden, though often termed parasitic, do not feed upon the tissues of the animal with which they live, and hence have a very different relation to them. Their food consists often of what is rejected by, or is even hurtful to, their hosts; and though the line between them and true parasites may not be easy to draw sharply, it is yet useful to recognize them under a distinct name, as proposed by Professor Van Beneden.

A New Genus of Cervidæ.—Mr. R. Swinhoe, who, as consul at Formosa and various stations on the Chinese coast, has done most active and important work in the investigation of the fauna of that part of Asia, described recently to the Zoological Society of London, a new form of deer, common on the islands at the lower part of the river Yangtse-Kiang, near Ching-Kiang, into the markets of which city it is often brought, though it appears hitherto to have escaped the observation of naturalists. This deer is distinguished by the long canines and the total absence of horns in both sexes. Mr. Swinhoe proposes to form a new genus for the reception of this remarkable form, and gives it the name *Hydropotes inermis*.

Animals presenting two distinct Sexual Forms.—From the time when the so-called alternation of generations became known to zoologists, they have been familiar with various species of lower animals which reproduce sexually under one form, and a-sexually under a totally different form, the form presenting agamic reproduction being often so different from that in which sexual maturity is ultimately attained, that at one time the two phases of the species have been referred even to different classes of the animal kingdom. The a-sexual Aphides, whose offspring become male and female adults; the Cecidomyia larvæ, producing a-sexually larvæ like themselves, which become eventually sexually mature flies; the various Entozoa and the Annelids of the family Syllidæ, which reproduce rapidly by fission, whilst at certain times individuals endowed with sexual organs, and differing most markedly in their setæ and other characteristics are produced,—are familiar instances. Lately, by the researches of Leuckart, Mecznikow, and Schneider, we have been made acquainted with a nematoid worm parasitic in the frog, which presents the remarkable condition, previously unparalleled in science, of two sexual forms: the first, in which there are distinct males and females, is a free living form; the second, to which the eggs of this bisexual generation give rise, is hermaphrodite, but at the same time truly sexual in its reproduction, according to M. Schneider, in which it differs from all previously recorded cases of alternation of generations. M. Claus asserts the same of the Nematoid, *Leptodera appendiculata*; and the Acaleph *Carmarina* has since been described as presenting the same condition of things. M. Claparede, of Geneva, amongst his other discoveries in the Bay of Naples, has brought to light a most interesting case among the highest Annelids of an animal presenting two distinct sexual generations. The *Nereis Dumerilii* is the worm to which these observations refer. For some time this species has been a puzzle to zoologists, and M. Malmgren had already detected its relation to Heteronereis; but the problem has been fully investigated by M. Claparede. He finds that there are absolutely two forms of sexually mature *Heteronereis* (each having its own males and females, as in nearly all Polychætous Annelids): one small and very agile, swimming on the surface of the sea, and thus widely dispersing its reproductive elements; the other much larger, but less agile, which never leaves the sea-bottom, and fitted rather to reproduce the species in a fixed locality. The eggs of the two forms of *Heteronereis* are not at all similar; but the zoosperms are identical in the two. This, however, is not the most remarkable part of the case; for it appears that these two forms of Heteronereis are neither more nor less than developed forms of the *Nereis Dumerilii*, which has also a sexual condition (consisting of both males and females) as a Nereis. We have in the *Nereis Dumerilii*, according to M. Claparède, a worm which is adult both as Nereis and Heteronereis, and has probably two Heteronereidan forms. An important question is whether a worm which has arrived at sexual maturity as a *Nereis* can lose again its sexual characters, and become a Heteronereis; or whether we must consider that a worm once arrived at maturity as a Nereis can never itself become a Heteronereid, but only the worms which it produces are destined for this condition. The question is one of importance, which must be solved by study of worms kept in the aquarium. Undoubtedly we have here one of the most astonishing cases of protean diversity of specific form ever brought before naturalists—of a kind, indeed, totally unexpected. The history of the Axolotl (chronicled by us some time since) presents a sort of parallel to this case; but it may prove that the resemblance is not so close as we might at present suppose.

M. Dumeril has shown that the Amphibian Axolotl of Mexico reproduces when in its larval condition with perennial gills, as known in the tropical region of Central America; and also that in colder regions losing these gills, it assumes the more perfect Salamandroid form, and is reproductively active in that condition. The perennibranchiate condition may be compared to the Nereis-form, the Salamandroid to the Heteronereis; but it is to be observed that the differences are much greater in the case of the two forms of the worm than in the Amphibian: also we have no parallel to the second Heteronereis form of the *Nereis Dumerilii*, which, by the way, is well named *à propos* of the distinguished herpetologist who has made known the sexual peculiarities of *Siredon*.

Miscellaneous.—The eminent comparative anatomist Professor Keferstein, of Göttingen, has died at the early age of thirty-seven. He was an active worker, from whom much in bibliological science had been already gained, and from whom much was to be expected.

The Sars Fund.—A subscription has been started for the family of the eminent Scandinavian zoologist, Michael Sars, whose death occurred last year. Whoever knows anything of marine zoology knows of the work of Sars and of his eminent son, G. O. Sars. In France and Germany the subscription is progressing, and in this country Mr. J. Gwyn Jeffreys has undertaken to receive contributions. We shall be glad to hear that the appeal to English savans has been successful.

Quarterly List of Publications received for Review.

1. On Comparative Longevity in Man and the Lower Animals. By E. Ray Lankester, B.A. *Macmillan & Co.*
2. Reports on the Progress of Practical and Scientific Medicine in different parts of the World. Edited by Horace Dobell, M.D., Senior Physician to the Royal Hospital for Diseases of the Chest. *Longmans, Green, & Co.*
3. Geology and Revelation; or, The Ancient History of the Earth considered in the Light of Geological Facts and Revealed Religion. By the Rev. Gerald Molloy, D.D., Professor of Theology in the Royal College of St. Patrick, Maynooth. *Longmans, Green, & Co.*
4. Our Domestic Fire-places. New Edition, entirely re-written and enlarged. By Frederick Edwards, jun. *Longmans, Green, & Co.*
5. Discussion of the Meteorological and Magnetical Observations made at the Flagstaff Observatory, Melbourne, during the years 1858–1863. By George Neumayer, Ph.D., late Director of the Flagstaff Observatory, &c. *Mannheim: J. Schneider.*
6. Education and Training, considered as a subject for State Legislation. By a Physician. *J. Churchill & Sons.*
7. Reliquiæ Aquitanicæ; being Contributions to the Archæology and Palæontology of Périgord, &c. By E. Lartet and H. Christie. Edited by T. Rupert Jones, &c., &c. *H. Bailliere.*
8. Statistics of New Zealand for 1868. Printed by order of the New Zealand Government. *Wellington: G. Didsbury.*
9. The Philosophy of the Bath, with a History of Hydro-therapeutics and of the Hot-air Bath from the Earliest Ages. By Durham Dunlop, M.R.I.A. *Dublin: Moffat & Co.*
10. Christianum Organum; or, the Inductive Method in Scripture and Science. By Joseph Miller, M.A. Introduction by J. H. Gladstone, Ph.D., F.R.S. *Longmans, Green, & Co.*
11. Choice and Chance. By Rev. W. A. Whitworth, M.A., Fellow of St. John's College, Cambridge. *Cambridge: Deighton, Bell, & Co.*
12. Preliminary Field Report of the U.S. Geological Survey of Colorado and New Mexico. By F. V. Hayden, U.S. Geologist. *Washington: Government Printing Office.*
13. Geological Report of the Exploration of the Yellowstone and Missouri Rivers. By the same Author.

14. The Book of Nature and the Book of Man. By Charles O. G. Napier, of Merchiston, F.G.S., &c. Illustrated with photographs and numerous woodcuts. *J. Camden Hotten.*

PAMPHLETS AND PERIODICALS.

Memoirs of the Geological Survey of India, published under the Direction of Thomas Oldham, LL.D., &c. *Calcutta.*

Report on the Filtration of the Water of the Hooghly. By David Waldie, F.C.S.

Analysis of the Khettree Meteorite, with an Account of its Fall. Same Author.

Reports of the Mining Surveyors and Registrars of Victoria. *Melbourne: John Ferres.*

On the Geographical Distribution and Physical Characteristics of the Coal-fields of the North Pacific Coast. By Robert Brown, F.R.G.S., Commander and Government Agent of the first Vancouver Exploring Expedition, &c., &c. *Edinburgh: Neill & Co.*

Observations on the Chalchihuitl of Mexico and Central America. By E. G. Squier, M.A., &c., &c. *New York.*

Dr. Walter's Doctrines of Life. Reply to London 'Lancet.' (From 'St. Louis Medical and Surgical Journal.')

A Physical Theory of Animal Life. A Review by Julian.

On the Identity of the Vital and Cosmical Principle. By R. Lewins, M.D.

The Nature of Man Identical with that of other Animals. By Julian.

On Colour Tests as Aids to Diagnosis. By John Day, M.D. From the 'Australian Medical Journal.'

Report of the Committee for the Purpose of Investigating the Rate of Increase of Underground Temperature Downwards, in various Localities, of Dry Land and under Water. Professor Everett, D.C.L., F.R.S.E., Secretary.

An Investigation into some previously undescribed Tetanic Symptoms produced by Atropia in Cold-blooded Animals, with a Comparison of the Action of Atropia on Cold-blooded Animals and Mammalia. By T. R. Fraser, M.D. *Edinburgh: Neill & Co.*

Midland Steam-Boiler Inspection and Insurance Co.'s Report.

Annual Report of the Secretary of the Interior for 1869. *Washington.*

Notes on Books (Quarterly List and Analysis). *Longmans.*

Microscopic Objects Figured and Described. No. 1, January, 1870. By J. H. Martin, Secretary, Maidstone and Mid-Kent Natural History Society. *Van Voorst.*

The Food Journal; a Review of Social and Sanitary Economy and Monthly Records of Food and Public Health.
London: J. M. Johnson & Sons, 3, Castle Court, Holborn.

Revue Bibliographique Universelle. *Paris: 77, Rue de Bac.*

The American Naturalist. Peabody Academy of Science. *Salem, Mass.*

Scientific Opinion.

The Geological Magazine.

The Photographer's Annual and Almanac for 1870.
J. W. Green, 54, Paternoster Row.

PROCEEDINGS OF LEARNED SOCIETIES, &c.

Proceedings and Papers of the Kilkenny and South-East of Ireland Archæological Society. *Dublin: McGlashan & Gill.*

Transactions of the Edinburgh Geological Society.
Edinburgh: Neill & Co.

Proceedings of the Literary and Philosophical Society of Liverpool. (1868-9.) *London: Longmans.*

Proceedings of the Manchester Literary and Philosophical Society. (Extract.)

Proceedings of the Royal Institution of Great Britain.

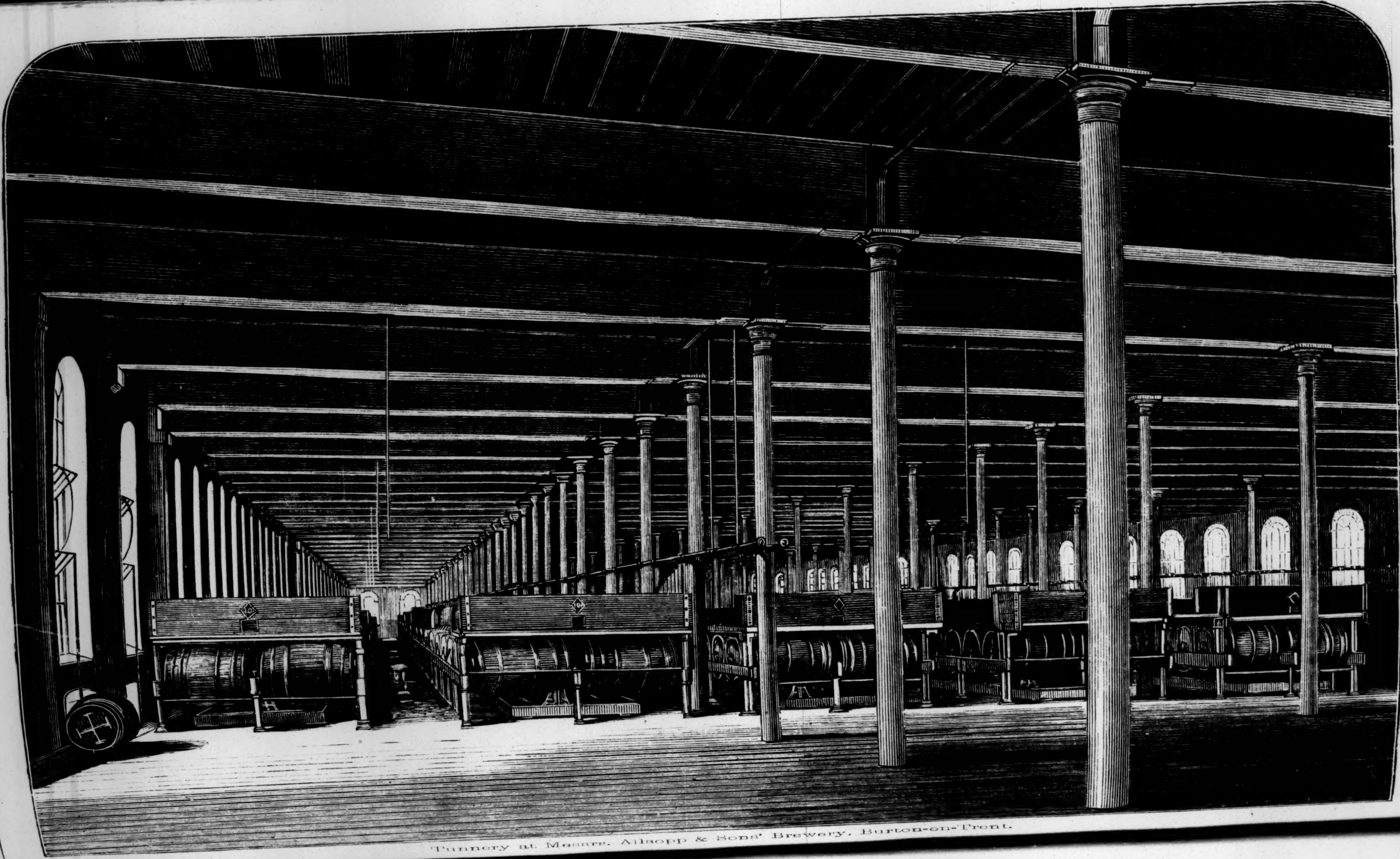
" " Royal Society.

Monthly Notices of the Royal Astronomical Society.

NOTICE TO AUTHORS.

⁂ Authors of ORIGINAL PAPERS wishing REPRINTS for private circulation may have them on application to the Printers of the Journal, Messrs. W. CLOWES & SONS, 14, CHARING CROSS, S.W., at a fixed charge of 30*s.* per sheet per 100 copies, including a COLOURED WRAPPER and TITLE PAGE, *but such Reprints will not be delivered to Contributors till* ONE MONTH *after publication of the Number containing their Paper, and the Reprints must be ordered before the expiration of that period.*

PLATE. I.—QUARTERLY JOURNAL OF SCIENCE, No. xxvii



Tunnery at Messrs. Allsopp & Sons' Brewery, Burton-on-Trent.